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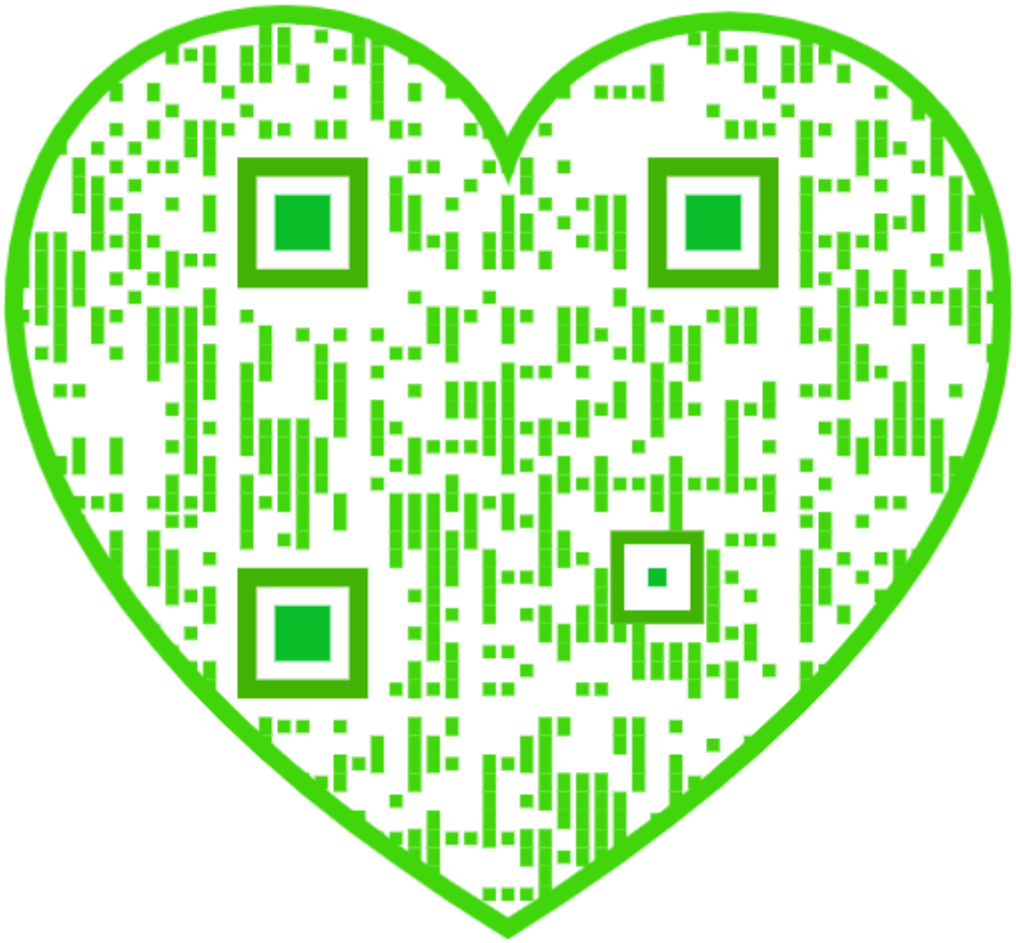

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EDITORIALS

Municipal and County Engineering

Beginning with the present issue, the name of this publication is amended to read: MUNICIPAL AND COUNTY ENGINEERING.

Friends of the paper have a right to inquire the reason for this change. For some time it has been felt, as recent editorials have indicated, that a too narrow interpretation was being placed on the former name, MUNICIPAL ENGINEERING. Although the editorial scope of the publication covered the engineering activities of counties as well as of cities, this fact was too often overlooked by the busy man of but slight acquaintance with the paper. He drew the false inference from the former title that the contents of the publication were of interest only to engineers and contractors engaged in public works activities in cities.

Since the real field of the magazine is city and county engineering, the logical change in name is thought to be that now made effective.

The word County is somewhat subordinated on the title page to avoid confusion. It is considered highly desirable to make this transition smoothly, with a minimum of annoyance to old friends of the paper. For this reason the word County appears in somewhat smaller type than the word Municipal. County engineers should not be misled by this typographical feature, however, into the belief that their interests will be secondary. It is the intention to treat adequately the problems of county engineers as well as those of municipal engineers.

It will readily be appreciated that the problems of municipal engineers and county engineers are so similar in their fundamental aspects that the needs of these two classes of engineers can best be served by a single publication at a minimum expense to the engineers, the publisher and the manufacturer patrons. There will also be a time economy in condensing in a single monthly publication the essential things of interest to these two classes of engineers and contractors.

Another point which should not be overlooked is that the individual who is a municipal engineer this year may be a county engineer next year. Also many municipal engineers do some county engineering work as well, and many county engineers do city work for small towns and villages within their counties who do not employ full-time engineers.

In a way, the change is a concession to usage, as the word "municipal" really should be interpreted to cover county as well. Usage, however, has so narrowed the meaning of the word municipal that it is usually taken to refer merely to the city, and so has been misleading.

Municipal engineers and contractors who long have supported the publication need have no fear that their interests will be neglected in the widening of the paper's field. They have been the backbone of the support of the publication since its foundation, twenty-eight years ago, and all considerations of gratitude, as well as of enlightened self-interest, will constantly prompt the publishers to safeguard the interests of these old friends in the municipal field.

Prospective Improvement of Highways Situation

The latest unofficial word from Washington expresses the hope-inspiring news that "there is every reason to believe that the highways situation is to be improved." The belief rests on statements emanating from headquarters. At a conference of chairmen of State Highways Transport Committees, held in Washington early in June, a representative of the railroad administration stated quite positively that the official attitude favors the full utilization of the highways and the building and improving of highways wherever necessary to aid the transportation situation and help materially in winning the war.

The railroad administration, in a circular, C. S. 13, on Car Supply for Stone, Sand and Gravel, issued May 24, has given some assistance to road building by opening the way for the transportation of road materials. The order co-ordinates all the federal departments interested in roads and the shipment of road materials, and provides for a committee to handle the entire road question.

Briefly, the rules state: That open-top cars, suitable for such traffic, should be furnished preferentially for the transportation of coal, coke and ore; that available cars, not suitable for coal, coke or ore, may be furnished for the transportation of stone, sand and gravel, and when so furnished shall be used preferentially for highway maintenance materials; that where suitable coal, coke and ore cars are available in excess of the number required, they may be furnished for the transportation of stone, sand and gravel, and when so furnished shall be used preferentially for highway maintenance materials. The return movement to mines or ovens should be utilized wherever practicable in furnishing car supply for stone, sand and gravel. Every endeavor should be made, the order states, consistent with keeping up the production of coal, coke and ore, to furnish shippers of stone, sand and gravel with a minimum of 40 per cent of their normal weekly transportation requirements. Roads not producers of coal, coke or ore must not use foreign open-top equipment for stone, sand or gravel shipments, except for one load in the course of the return movement to mines or ovens.

Where the transportation needs of essential road construction or maintenance projects cannot be met by car supply furnished in accordance with the above rules, the state, county or municipal officials in charge of the work should, through their proper state highway department, apply to the Director of the Bureau of Public Roads, United States Department of Agriculture, Washington, D. C., for assistance. Such applications will be considered by representatives of the Department of Agriculture, the War Department, the War Industries Board, the Fuel Administration and the Railroad Administration, and, in accordance with the recommendations of such representatives, the Car Service Section will endeavor to furnish car supply

necessary for approved essential road construction or maintenance.

It is believed that this committee will approve of proceeding with a large amount of road work.

Dramatic Demonstration of Interstate Motor Haulage

Of high dramatic, as well as utilitarian, interest was the recent speedy removal by motor trucks of the furniture and records of the Emergency Fleet Corporation from the city of Washington to Philadelphia, with but the loss of one-half a business day. A more showy demonstration of the flexibility and feasibility of the intercity and interstate haulage of freight, by motor trucks, over the highways, could scarcely be conceived by the most imaginative publicity man.

Sixty trucks were used on this hegira. Four round trips were made between the two cities, between the close of business in Washington on Friday and the opening of business in Philadelphia on the next Monday morning. This great undertaking was rendered still more difficult by the necessity of collecting the furniture and records of the corporation from 39 different and well-scattered buildings in Washington before the run to Philadelphia could be made. These offices employed thousands of clerks and stenographers. The office equipment amounted to several hundred tons. The truck fleet, on its first trip, moved 600 office desks, as well as a large number of filing cabinets, typewriters and chairs.

Such a dramatic demonstration of the utility of motor freight haulage over the highways, occurring at the national capital, and connected directly to a win-the-war measure, ought to awaken great interest in high places in this form of war-time transportation. We hope Mr. McAdoo was told of the incident.

Effect of Retroactive Freight Rate Increase on Road Contracts

Unless relief is granted, the burden placed on road contractors, who have contracts under way, by the proposed increase in freight rates promulgated in Order No. 28 of the U. S. Railroad Administration, will be borne with the greatest difficulty, if, indeed, it can be borne by them at all. Unless relief is forthcoming it is feared that many contracts undertaken before the announcement of the rate advance will be abandoned. Naturally this will leave the road construction work of the country in an acutely chaotic condition—the present highway transportation confusion will become worse confounded.

At a meeting held in Detroit on June 11, the Highway Industries Association adopted a resolution urging the suspension of the rate advance on road materials needed on contracts undertaken before the promulgation of Order No. 28. The order, as a whole, was not protested, but its retroactive feature was protested. State highway officials were present and took an active part in preparing the resolution.

The resolution as adopted recited that since the maintenance and construction of necessary highways require the successful continuance of existing contracting organizations and of producers of road-building materials, interests involving over one billion dollars of invested capital; and since the freight rates on road building materials promulgated by the Director General of Railroads in General Order No. 28, dated May 25, 1918, is retroactive with reference to existing contracts for road work in all parts of the country; and since such retroactive effect will result in serious financial loss, amounting to a very large percentage of the whole value of such contracts and entailing financial ruin to many contractors and producers of materials, without gain to the state; and since existing state statutes prevent public officials from giving relief to contractors on public works who suffer loss by reason of these freight-rate increases, it was resolved that such increased freight rates be suspended in so far as they apply to materials necessary for the execution of work under contracts in force prior to the promulgation of Order No. 28.

No informed person can question the fairness of this resolution. There are hazards enough in the contracting business at the best of times, and it should not be subjected to any retroactive form of war taxation. Let every person, informed in the premises, write the Director General of Railroads, Hon. Wm. G. McAdoo, Washington, D. C., urging that this rate increase be suspended as stated in the resolution. Perhaps in no other way can the attention of this busy official be focused on the essential injustice of Order No. 28 to road contractors engaged on contracts undertaken before this unanticipated order became effective.

Drainage and Irrigation of Homesteads for Returned Soldiers

The ribbon clerk who has gone up against the iron at the front and who has acquired a liking for life in the open, will doubtless welcome an opportunity to engage in a full-grown, male occupation after he receives his honorable military discharge. At any rate, this is the view held by Secretary Lane, of the Department of the Interior, who proposes an appropriation of $2,000,000 to his department to defray the cost of making a complete survey of the available publicly and privately owned, but undeveloped, land in the United States. He holds that it is important to know not simply the quantity of idle land, but to have complete information as to its value, its productive possibilities, the cost of reclamation, and the cost, where privately owned, of purchase.

"All this should be done on a definite planning basis," said Mr. Lane, in writing the President. "We should think as carefully of each of these projects (irrigation, drainage, clearing) as George Washington thought of the planning of the city of Washington."

The Secretary considers the sum of $2,000,000 ample to launch this preliminary work and to carry it forward. He wants to begin right now. He has been thinking of demobilization. He knows that an army of millions cannot be demobilized and reabsorbed into industry over night any more than it can be mobilized, trained and equipped over night. The "ground springers" failed at one end of the war, and unless we take thought in time they will fail at the other. The million men who, pacifists said, would spring to arms between sunrise and sunset, when the call came, didn't spring, and, if they had sprung, would have found no arms. Is there never to be an end to unpreparedness? Shall we allow ourselves to be as unprepared for peace as we were for war? Or shall we adopt Mr. Lane's wise and timely suggestion and get this great reclamation project under way forthwith? If we do, the engineer will do his part to make ready by drainage or irrigation a parcel of ground to which the unattached, discharged soldier can spring—and cling.

PAVEMENT DESIGN AND CONSTRUCTION

Details of Construction of Stone Block Pavements

By Arthur H. Blanchard, M. Am. Soc. C. E., Consulting Highway Engineer, New York City

The unexcelled durability of stone block pavements has been recognized for centuries; in fact, ancient records show that stone blocks were used in the construction of roadways built between 1000 and 2000 B. C. Although the Romans fully appreciated the economic value of a stable foundation, Telford, in 1824, was apparently the first engineer to recognize the efficiency of small size blocks cut in such a manner as to give close joints. In France, soon after the establishment of the National Department of Roads and Bridges, the stone block pavement was used as the standard type of construction for sections of the national highways within urban districts, a typical case being shown in Fig. 1. In the United States the development of the stone block pavement began in 1876, when New York City first used the rectangular block. Intermittent improvements have been made during the past forty years, the primary objects in view being to construct the most durable type of pavement with a smooth, uniform, impervious surface, and, in municipalities, to be so built that it could be economically repaired after openings had been made for sub-surface work.

The Stone Trackway

Although this article will be devoted to details of construction of stone block pavements laid with, first, the usual form of rectangular block, and, second, rough cubical blocks, it should be noted that the stone trackway, laid usually as a part of a stone block pavement, has been used with successful results in several European cities and rural districts, Fig. 2 showing the typical form of construction employed in Liverpool, England. Usually these trackways consist of rectangular stone blocks ranging from 10 to 18 ins. in width, 6 to 8 ins. in thickness and from 2 to 4 ft. in length.

Drainage, Foundations and Curbs

The high initial cost of stone block pavements and the fact that this type of pavement is generally used under the heaviest traffic, requires that no expense should be spared to secure ideal sub-surface drainage. It is practically universal practice to use cement-concrete foundations for stone block pavements. The thickness of the foundation should be based upon the probable development of traffic during its life, which can be safely taken at 50 years. Under no circumstances should less than 6 ins. of 1:3:6 concrete be used, and in many cases from 8 to 12 ins. should be employed. In municipalities it is almost universal practice to lay stone block pavements between sidewalk curbs, but on highways outside of urban districts such curbs do not generally exist. In such cases, where sand cushions are employed, it is essential that cement-concrete edging should be constructed on each side adjacent to the stone block paving.

Properties of Stone Blocks

Although trap rock, limestone and quartzite have been used in the manufacture of stone blocks, granite and sandstone are generally employed, the use of the former largely predominating. Independent of the kind of rock from which stone blocks are manufactured, they should be of such quality that they will resist abrasion, shocks, crushing and weathering and will not become round and smooth under the action of traffic. Furthermore, they should be of uniform quality and texture, without seams, scales or discolorations. Fig. 3 shows wear of granite block paving due to tracking of heavy traffic.

Specifications

In specifications it is highly desirable to include specific requirements for toughness, percent of loss in the Deval abrasion test, and crushing strength. Without doubt the toughness test is more universally used in specifications than any other. This test, however, is primarily a criterion of the quality of the block to resist shock. It is therefore important that the maximum allowable loss by abrasion, the measure of the quality of the block to resist wear, should be specified.

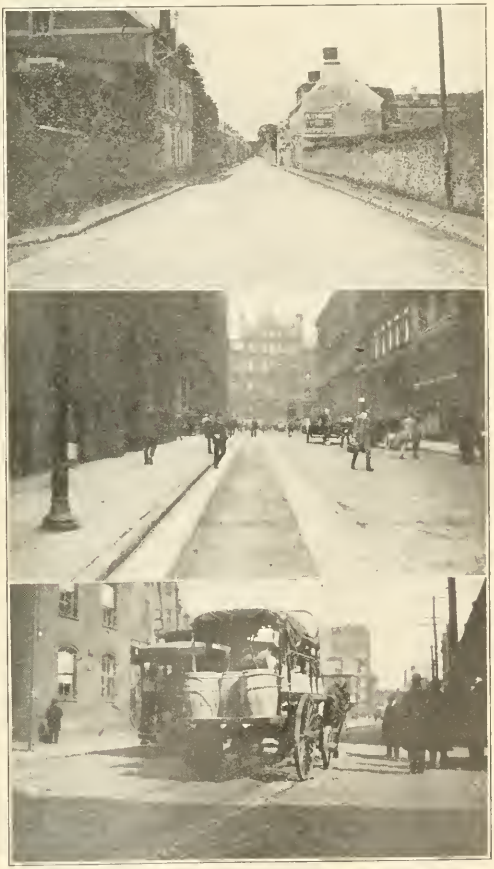


FIG. 1 (TOP): TYPICAL STANDARD STONE BLOCK PAVEMENT IN FRENCH URBAN DISTRICT. FIG. 2 (CENTER): TYPICAL STONE TRACKWAY, LIVERPOOL, ENGLAND. FIG. 3 (BOTTOM): WEAR OF GRANITE BLOCK PAVING DUE TO "TRACKING" OF HEAVY TRAFFIC.

Minimum Crushing Strength

The inclusion of a minimum crushing strength is at present

a debatable question among paving engineers. Frequently the statement has been made that it is unnecessary to include this test, which is the criterion of the block to resist crushing under heavy concentrated tire loads, as all granites used for paving blocks show a crushing strength above 20,000 lbs., the average specification requirement. Such, however, is not the case, as granites tested on work with which the writer has been connected showed a crushing strength per square inch as low as 15,500 lbs., and several showed crushing strengths of about 19,000 lbs. Often it is taken for granted that a granite which shows a fair toughness and a high hardness always possesses a high crushing strength. Such is not the case; for example, the granite having a crushing strength of 15,500 lbs. showed a hardness of 19.1 and a toughness of 8, whereas a granite block which showed a crushing strength of 21,500 lbs. had a hardness of 18.4 and a toughness of 4.

Minimum Requirements for Granite and Sandstone

The minimum requirements for granite blocks should be that the granite should have a percentage of wear of not more than 4.5, a toughness of not less than 8 and a crushing strength of not less than 20,000 lbs. per square inch. Sandstone blocks should fulfill the above requirements, except that the crushing strength should be not less than 16,000 lbs. per square inch. The acceptance of blocks based on testing should be along the same general lines as in the case of the acceptance of paving brick—that is, blocks from every shipment for a given contract should be tested.

Size of Blocks

The best practice specifies that the blocks shall be not less than 8 nor more than 12 ins. in length on the wearing face; not less than 3½ nor more than 4½ ins. wide on the wearing face, and not less than 4¾ nor more than 5¼ ins. in depth. In some cases, especially if the granite has a high toughness and a low loss on abrasion, excellent pavements have been constructed with blocks 7 to 11 ins. in length and with an average width and depth of 4 ins.

Dressing

If a first-class granite block pavement is to be constructed, rigid specifications covering the dressing of the faces of the block must be used. The 1917 specifications of the American Society of Municipal Improvements, quoted herewith, satisfactorily cover this detail:

"The blocks shall be so dressed that the faces will be approximately rectangular in shape, and the ends and sides sufficiently smooth to permit the blocks to be laid with joints not exceeding ½ in. in width at the top, and for 1 in. downward therefrom, and not exceeding 1 in. in width at any other part of the joint. The top surface of the block shall be so cut that there will be no depressions measuring more than ⅜ in. from a straight-edge laid in any direction on the top and parallel to the general surface thereof."

Cushion Beds

Usually a sand composed of clean, sharp grains, all of which will pass a ¼-in. screen, is used for a cushion. The smoother the surface of the concrete foundation and the less the variation in the depth of blocks, the thinner it is practicable to make the cushion, but it should never be less than ¾ in. The utilization of a sand-cement mortar in place of sand is at present a mooted question, and only service tests of long duration can establish its economic value and its advantages or disadvantages. It has been suggested that if a good bituminous cushion could be provided, it would undoubtedly be preferable to either a mortar or a sand cushion, but its increased efficiency must be carefully considered to determine if its use would justify the increase in cost.

Laying Rectangular Stone Blocks

After the cushion bed of sand has been uniformly spread, the stone blocks should be laid in courses at right angles to the curbs or edgings, except at street and road intersections. An easy method of laying the blocks to line and grade is to use iron pins and lines, the latter being at a fixed height above the finished surface grade between adjacent pins. Transverse grade lines between stakes and templates are also successfully employed for this purpose. The blocks should be so laid that all joints are as small as possible, not over ⅜ in., and so that all longitudinal joints shall lap by at least 3 in.—see Fig. 4. After laying, the blocks should be rammed—see Fig. 5—to a

FIG. 4 (TOP): CORRECT METHOD OF LAYING STONE PAVING BLOCKS WITH THIN JOINTS. FIG. 5 (CENTER): BLOCKS RAMMED TO SOLID BEARING, TO EVEN CONTOUR AND TRUE CROSS-SECTION. FIG. 6 (BOTTOM): HOT MORTAR FLUSHED TO SURFACE OF BLOCKS AND PUSHED INTO JOINTS BY SQUEEGEES.

solid bearing, the wearing surfaces of the blocks being in even contour and true to the desired cross-section. The ramming should closely follow the laying, as otherwise the blocks are liable to be tilted by being walked upon.

Filling the Joints

The primary objects to be attained in the filling of joints in stone block pavements are, first, permanent imperviousness; second, a stable filler flush with the wearing surfaces of the blocks; and, third, in the case of urban districts, a filler which will permit openings to be economically made in the pave-

ment, which condition implies that operations of removing and restoring sections of the pavement may be done at a minimum cost and that practically all the blocks may be reused. Tar-pitch-sand and asphalt fillers, possessing essential physical and chemical characteristics, will satisfy the three conditions stipulated if properly used. Well-constructed cement-grouted joints comply with the first and second essentials, but not with the third.

Different Kinds of Fillers

The following excerpt from the 1918 report of the committee on roads and pavements of the American Society of Civil Engineers ably covers the relative merits and disadvantages of using the different kinds of fillers:

"The joints should be filled with water-proof material. For this purpose a Portland cement-grout, asphalt or some other bituminous filler is generally used, and in some cases sand is mixed with a bituminous material in order to increase the toughness of the filler. All these fillers give good results, but with cement-grout the cost of taking up and restoring the pavement over cuts is increased over that of a bituminous filler, as in many cases blocks are broken in taking them up, and it is difficult to clean the cement from the individual blocks and also to keep the traffic from the cut or patch while the grout is setting after the pavement has been restored. Another disadvantage of the cement-grout filler is that it is highly important that it be perfectly set before traffic is allowed on the pavement, and in large cities it is almost impossible to keep traffic from the pavement, after it is laid, for the necessary length of time."

Brodie's Specification for Tar-Pitch-Sand Filler

The modern practice of using a tar-pitch-sand filler was first developed by John A. Brodie, city engineer of Liverpool, England. His standard specification for a Welsh granite or syenite block pavement is as follows:

"For heavy traffic sets 5 ins. to 8 ins. long by 4 ins. wide by 6¼ ins. deep are used; they are paved in bonded courses upon a foundation of Portland cement concrete. For the heaviest traffic, for example, streets in the neighborhood of the docks and warehouses, where loads of 30 tons on four wheels are not uncommon, the thickness of the foundation is 8 ins., but for ordinary heavy traffic 6 ins. is the depth adopted. A cushion of fine gravel ½ in. thick is interposed between the sets and the foundation, and the joints, after being filled with dry shingle, are grouted with a hot pitch and sand mixture."

Best American Practice with Tar-Pitch-Sand Fillers

The best American practice with tar-pitch-sand fillers calls for a tar-pitch, having a melting point of about 50 degs. C., heated to between 150 and 200 degs. C., and mixed with as much hot sand, all of which passes a 20-mesh sieve, as the tar-pitch will carry, but never less than a one tar-pitch to one sand mortar. After being thoroughly mixed, the hot mortar is flushed on to the surface of the blocks—see Fig. 6—and pushed into the joints by squeegees or other tools. It is good practice to go over the joints at least twice and fill all cavities which can be found. To insure good work, two points should always be borne in mind: first, the sand should remain uniformly suspended in the hot tar-pitch; second, the joints should be dry at the time of pouring.

The American practice of using asphalt and cement-grout fillers will not be described or discussed, as the methods employed have become well standardized through many years' experience in the construction of brick pavements, as well as stone block pavements.

Durax Pavements

Small stone block pavements known as Durax have been laid to a considerable extent in England. The principal feature of the pavement is the small, irregular size of the blocks, approximating cubes 2¾ to 4¾ ins. in size. At the present time practically all blocks are made with specially designed machines—see Fig. 7. An efficient operator at one machine can make on an average 2,400 blocks in a 10-hour day. They are sufficiently irregular, both in size and shape, to permit them to be laid in arcs of circles of comparatively small radii and so that the joints will not be excessively large. By laying the courses in circular arcs practically none of the joints are parallel to any line of traffic. In Europe these blocks have

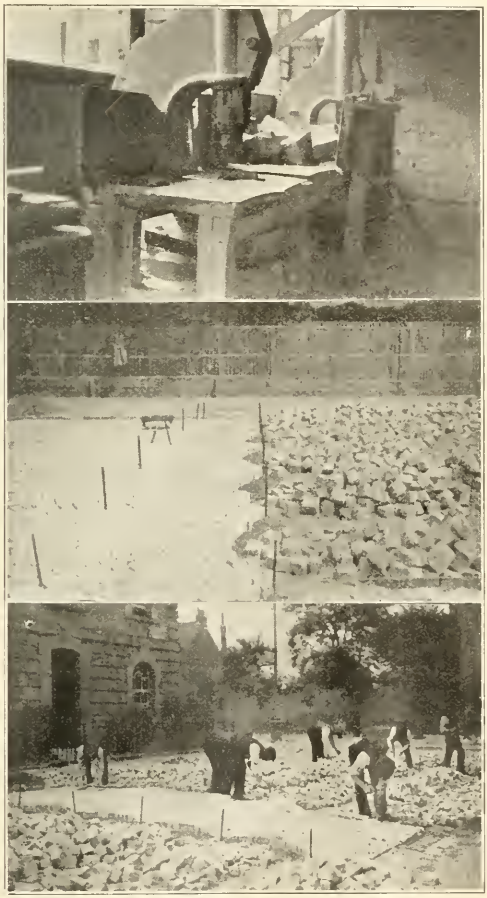


FIG. 7 (TOP): MACHINE FOR MAKING DURAX PAVING BLOCKS. FIGS. 8 AND 9 (MIDDLE AND BOTTOM): STRINGS STRETCHED BETWEEN IRON PEGS FOR GUIDES IN PLACING DURAX STONES FROM WHICH ADJACENT ARCS ARE SPRUNG.

been used to a great extent in resurfacing the broken stone roads where the traffic is too heavy for the macadam and to some extent on city streets. They have been used to a slight extent on pavements in some cities in the United States.

The current practice in constructing a Durax stone block pavement in England is typified by the method used in laying the Durax pavement on Victoria Road, in Eltham, in 1913. On a prepared macadam foundation tarred sand was laid to such a depth that, after the Durax cubes were rammed, the depth of sand was between ¼ and ½ in. The alignment of the blocks and the number of arcs in a transverse section were controlled by iron pegs driven into the macadam foundation prior to the laying of the blocks. Strings stretched between

these iron pegs served as guides for the placing of the stones, from which adjacent arcs sprung—see Figs. 8 and 9. The largest cubes were laid at the center of the arcs and adjacent thereto, while the smallest cubes were laid near the springing lines. The arcs were so laid that the cords averaged 3 ft. 6 ins. and the middle ordinate varied between 9 and 10 ins. After the joints of the blocks were filled with clean stone chips, the blocks were well rammed. The final operation consisted in pouring the joints with hot pitch and covering the surface

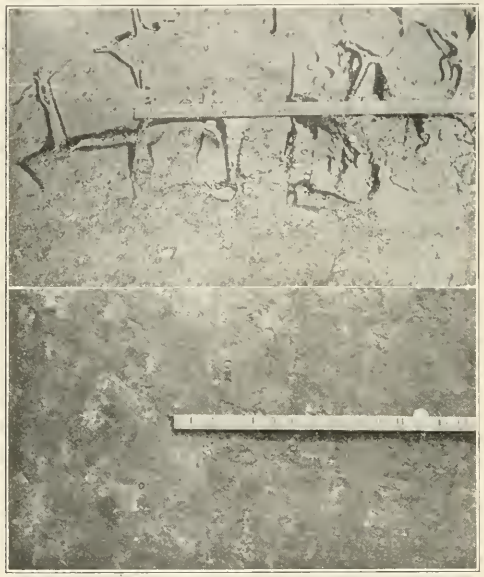


FIG. 10 (TOP): DURAX PAVEMENT—POURING JOINTS WITH HOT PITCH AND COVERING SURFACE WITH GRAVEL. FIG. 11 (BOTTOM): SURFACE OF FINISHED DURAX PAVEMENT.

with gravel—see Fig. 10. The surface of the finished pavement is shown in Fig. 11. The cost of this Durax pavement was 8 shillings ($1.95) per yard super, with foundation, the work being carried out by contractors under a 5-year maintenance contract. The blocks used in the pavement were furnished by the Durax Dustless Roads, Limited. This company manufactures these blocks in three grades, having the following limiting edge dimensions: 7 to 9 c.m. (2¾ to 3½ ins.), 8 to 10 c.m. (3¼ to 4 ins.), and 10 to 12 c.m. (4 to 4¾ ins.) One grade is furnished for the construction of a given pavement.

The McClintock Cube Pavement as Developed in Monroe County, New York

By J. Y. McClintock, County Superintendent of Highways, Monroe County, Rochester, N. Y.

The McClintock cube pavement was devised by the writer to remedy the defects and to take full advantage of the good points of macadam pavement. Following macadam, it was assumed that if the individual stones were cubical in form, the greatest wear could be secured from the material. These cubes should be made as small as would resist the crushing action of wheels, so a cube about 2 ins. in dimension has been adopted.

During the past eight years they have been manufactured of different materials and stretches of the road have been laid in this county under varying intensity of traffic. Cement concrete cubes, when made by local town labor from gravel alongside the road, are found to be inexpensive, but do not successfully withstand the freezing and thawing. Although we feel that cement cubes made with selected material would stand up pretty well, yet to date, the best results with this pavement have been obtained by the use of vitrified shale of which a number of miles of pavement near the city and in the city of Rochester have been laid. Possibly, the most successful cubes laid were those made from local clay mixed with coal ashes, and also cubes made of local clay mixed with a percentage of refractory clay brought from New Jersey. The cubes are laid on a foundation usually 5 ins. thick of broken stone with the joints filled with fine material.

Some of the best pieces have been laid by town superintendents, using local farmers for labor. The pavement rides smoothly and is lasting; it does not have any tendency to shove; it does not require periodical oilings; in fact, it furnishes one of the most promising systems of pavement now in use.

National Military Highways

By George C. Warren, 142 Berkeley St., Boston, Mass.

In times of war it is impossible to think of important commercial highways without thinking of military highways as one and the same. Good roads in times of peace are one economic means toward preparedness for war. In fact, except that war includes munitions and other means of destructive offense and defense, what is war preparation if it is not highly efficient emergency business?

Brigadier-General William M. Black, Chief of Engineers of the United States Army, who will be readily credited with being one of the highest authorities in the world on such matters, says:

"The part that is not working itself out is the co-ordination of the roads of the various states so that we will have through highways. The general government has to look beyond state limits. It has to get through routes, and it should be able to require that an improved highway system of one state connects with the highway system of another state. *As a rule, the highways most needed for federal purposes will be those that will also be most used for commercial purposes*, and it is simply a question of having such federal supervision as will see to it that the most needed roads are built first.

"It is scarcely necessary to tell you what transportation means to the commercial life of the country; and steps must be taken, and those promptly, if we expect to make the most of our national strength and play the part cut out for us over on the other side. The time for talk has gone; action now is imperative."

Gen. George W. Goethals, Chief of Ordnance, who, perhaps above all others, is known by the public as a practical military engineer who "does things," and does them efficiently and promptly, is quoted as saying:

"If the state should await the return of lower cost prices there will result attendant loss of business and consequently a higher ultimate cost of all things considered, and any difference in cost would not warrant such a curtailment of the enterprise, and so far as that viewpoint is concerned, in the opinion of many economic authorities, lower construction price conditions will never return."

Representative Greene, of Vermont, in an article in the *Army and Navy Journal*, says:

"It is obvious, when one stops to think of it, that if the construction of public roads under federal aid continues, without some eye to the possible use of those roads for military purposes, they will not be constructed in such a manner as to permit the transportation of the army and its supplies in time of great necessity."

Taken together, these brief quotations state the fundamen-

tal, present United States road problem in a nutshell. Given any road improvement project which is important commercially, either in developing agricultural, manufacturing or mining sections, or relieving the stress on the steam or electric railroads, and we have a "Win-the-War" measure of the highest importance. Given a connecting chain of such roads, and we have what would be needed for moving troops and munitions in times of active conflict in such sections.

We read in the daily papers at this moment that the government is seriously considering the expenditure of $1,000,000,000 in improvement of the railroads. It is in no criticism of that project, and, in fact, it is in appreciation of the importance of improvement in railroad facilities, which, until we

LEFT: (NO. 1, SEE TEXT) CONCRETE FLOORING ON STATE ROAD NO. 3. IN DONA ANA COUNTY, NEW MEXICO. RIGHT: (NO. 7) TYPE OF PRAIRIE ROAD USED IN SANDY, GRASSY PLAINS COUNTRY.

were put to the test of war, we all thought were most highly efficient, but it is without knowing whether one billion is too much or too little, that the writer wishes to go on record as saying that he believes that, dollar for dollar, any amount wisely expended in high-grade road construction is fully as important and will accomplish fully as much as a "Win-the-War" measure as expenditure in railway improvement.

May we not hope that the government will approach the matter from that point of view, and let "National Military Highways" and "National Railways" go hand in hand in hand as two of the most important factors of war activity.

Beyond the matter of "Win the War," such a policy is the most important preparation for assisting the world in reconstruction immediately after the Allies have won the war.

It is perfectly clear to all that in the reconstruction period the United States will be the most important factor, as it is now the most important factor in war activity, without which assistance it is clear the war would have been lost to the Allies.

Unusual Types of Roads and Road Structures Designed for Conditions in New Mexico

By James A. French, State Highway Engineer, Santa Fe, New Mexico

The views shown herewith are out of the usual line of road and road structures found in the burned area, and are adopted for many reasons and conditions obtaining in New Mexico.

Concrete Floorings

The concrete flooring is a type of structure used in the dry sand arroyos (dry streams) that are subjected to floods probably once or twice a year following cloudbursts, and more particularly where the sand is light and of a drifting nature. They are also only adaptable to arroyos where the stream bed has a gradient lighter than about 4%. They are generally built of coarse rubble concrete on the bottom and finished off with a superior mixture of concrete, though in many places suitable to materials available, a 1:3:6 concrete is used, depending entirely upon traffic conditions. The floor is 8 in. thick and 16 ft. wide. In photo No. 1, State Road 3, Dona Ana county, built some six years ago, the design was made to have the lower downstream edge of the floor about 3 in. below the bed of the arroyo. This is for the reason that should the lower edge of the floor be on grade or rather above, it will act as a weir with the result of scouring out below, endangering the crossing. By placing the floor just below grade the result is that each flood immediately covers the flooring with sand and gives it absolute protection, and maintains the grade of the stream bed. This necessitates cleaning off the sand, a couple of hours' work, but is much cheaper than trying to protect the scouring out effect if the floor is too high.

No. 2 is a sample of a concrete flooring just being finished, May 31, 1918. The picture does not show well its relative location as described in No. 1. This is one of several floorings on State Road 32 in San Juan county.

No. 3 is a type used where the arroyo bed is rock or not likely to scour below the overflow. A small culvert is used to carry off the low water. A covering of concrete on the

NO. 3—TYPE OF ROAD FLOORING USED IN NEW MEXICO WHERE ARROYO BED IS ROCK OR NOT LIKELY TO SCOUR BELOW FROM THE OVERFLOW.

rock surface would answer the purpose just as well, but of course would change the profile and grade of the road.

Nos. 4and 5 are concrete floors, but owing to the elevation of the floor, protective work must be carried on on the downstream side after floods. These two floorings are on State Road No. 3, in Otero county.

No. 6 is a flooring on State Road 32 in San Juan county, just completed.

Type of Prairie Road

No. 7 is a type of prairie road much used in the sandy, grassy plains country. These roads are constructed by devices built to drag out the two ruts—cost about $5 per mile, and where the soil and grass conditions are favorable, last for many years without maintenance. They are very fast for auto traffic and give comfortable riding. They are adapted to light, flat grades only. In this particular picture there is

no runoff from storms and the road is five years old without one cent of maintenance. This particular stretch shown is a tangent some 15 miles in length—State Road 9, Socorro county.

Road Through Heavy Sand

No. 8 shows a type of road through heavy sand. The sand is removed to the hardpan below and sloped on the side opposite to which the prevailing winds blow to about 1 to 3. This keeps the road clean of sand. The only rain that falls on the road is in the road section itself. There is no water runoff from the surrounding country. The layer of sand at this particular place averages 5 ft. in depth; State Road 18 in Chaves county.

Cattle Guard

No. 9 shows a type of cattle guard. These are crossings through fences to prevent cattle getting past. In the road center between the guides is a floor grating. Cattle will not pass over them. These guards are necessitated at fences in the cattle grazing counties. Gates are provided alongside of the guards for teams and wagons.

UNUSUAL TYPES OF ROADS AND ROAD STRUCTURES FOR CONDITIONS IN NEW MEXICO.
Top Row: (No. 2, See Text) Sample of Concrete Flooring; (Nos. 4 and 5) Concrete Floors on Road No. 3 in Otero County.
Bottom Row: (No. 6) Concrete Flooring on Road No. 32 in San Juan County; (No. 8) Type of Road Through Heavy Sand; (No. 9) Type of Cattle Guard.

Construction Plant and Methods Employed in Paving Seven Streets With Brick in Mt. Vernon, Ohio

By Arthur A. Graham, Paving Contractor, Mt. Vernon, O.

The work here described consisted of the paving of seven streets in the city of Mt. Vernon, Ohio, with the necessary drainage to take care of the surface or storm water. Work was commenced on July 29, 1916, and completed Nov. 17, 1917. The contractor was greatly handicapped by the shortage of labor and particularly so by the slow delivery of material due to poor transportation facilities.

The drainage system required 1,330 ft. of 39-in. segment block sewer and 688 ft. of 30-in.; also 1,650 ft. of 24 vitrified sewer pipe, besides the necessary laterals of smaller pipe connecting the catch-basins. There were 21 standard and 12 special catch-basins and 14 manholes. This work required 4,000 cu. yds. of trench excavation, which was all done by hand and backfilled with a Double-Quick power back filler. The paving proper necessitated the moving of about 12,000 cu. yds. of dirt, which was loaded by hand and hauled on dump wagons to various lots and dumps near the work.

Much of the curb was set in advance of the grading so as to eliminate the tearing up of the street far in advance of the work and the possibility of winter catching the contractor with the street in bad condition. The fall of 1916 found the contractor with about 50% of the work completed; two streets being entirely completed and work had been done on all but one of the other five, yet he had only one-half block of street that was not open to traffic.

There was in all 12,750 ft. of Berea sandstone curb and 8,000 ft. of cement curb and gutter. The sub-grade was rolled with a 5-ton tandem Springfield steam roller. The same roller was used on the brick. All brick were of the repressed type and the Ohio State Highway tests were required. The filler used on all streets was tar and was all poured or tracked. There were 25,000 sq. yds. regular and 1,350 sq. yds. of hillside brick, all on a 6-in. concrete base of 1:3:6 mix. Local gravel

VIEWS ON BRICK PAVEMENT CONSTRUCTION IN MOUNT VERNON, OHIO.
Each View Illustrates Use of Mathews Gravity Brick Conveyors. Center View Shows Template for Striking Off the Sand Cushion.

was used as it came from the creek bars. The base was struck off by a double template made of two planks, spaced about 12 ins. apart and dragged along the curb. The sand cushion was struck by the same template; 1-in. strips being nailed on the under sides where riding on the curb.

In general the contractor worked 3 gangs of men under 3 foremen and superintended all the work personally.

Matthews gravity brick conveyors were used on the work, two 16-ft. conveyors on rollers being used to convey the brick from the side of the street to the setters. The contractor also had a 12-ft. section, same as above, that he used to unload box cars. After the center of the car had been pitched out the conveyor was placed so the apron would just come outside of the door, and it was found to be very handy to take the brick from this and place them in the wagons.

Personnel

While this work was in progress W. S. Anderson was city engineer, C. G. Snow, director of public service and A. S. Blinn, consulting engineer to the contractor. The writer was contractor on this work.

VIEWS ON BRICK PAVEMENT CONSTRUCTION AT MOUNT VERNON, OHIO.
Left: Rolling Subgrade with Tandem Motor Roller. Note Use of Berea Sandstone Curbing. Right: Pouring the Tar Filler.

Okmulgee County, Oklahoma, Warrenite Roads

On May 30th, after 10 days' trial, Judge Higgins, of McAlester, Okla., holding court in Okmulgee, decided in favor of the contract and defendants a suit brought by certain taxpayers to enjoin the carrying out of a contract awarded in December, 1917, for the laying of 55 miles of Warrenite road, and grading and draining of 63 miles additional.

The taxpayers voted a bond issue of $800,000 for the improvement and the bonds were sold at a premium of $40,000 in the year 1917. The contract was let under plans and specifications prepared by Harrington, Howard & Ash, consulting engineers of Kansas City, Mo., and the contract for Warrenite to be laid on a compressed stone base was awarded to the Western Paving Co., of Oklahoma City, Okla.

The plaintiff raised and stubbornly fought every possible statutory jurisdictional and practical question.

Depositions were taken in all sections of the United States and a large number of experts on both sides gave oral testimony at the trial which lasted from May 20th to May 29th, inclusive, including several evening sessions. At the conclusion Judge Higgins, from the bench, decided against every point raised by the plaintiff and denied the injunction for which the plaintiff asked.

The roads to be improved connect the cities of Okmulgee, Henryetta, Morris and Beggs and the surrounding country, which is rich in oil, coal, grazing and agricultural resources. The heavy traffic accompanying the recent development of these important resources has made the dirt roads nearly impassable.

Some Hints On the Construction and Maintenance of Asphalt Pavements

By C. A. Mullen, Milton Hersey Co. Ltd., 84 St. Antoine St., Montreal, Quebec

Hauling

Hauling asphalt to the street is not attended with any very great difficulty. Cities should insist that the wagons be tight enough to prevent the material being dropped all along the route from the plant to the job. The rest may be safely left to the contractor or the manager of the city plant, a minimum temperature for laying being provided as a check against poorly compressed work, said Mr. Mullen in addressing the recent Canadian Good Roads Congress.

Whether wagons or auto trucks will prove more economical is always a local problem. The auto trucks are good for long hauls with steep grades, but there is frequently greater economy in the wagon for short hauls with flat grades. Provisions should be made for the rapid loading and unloading of either, but especially the automobiles. The author remembers figuring on one job that it cost 1 cent a minute to have a horse-drawn wagon of 3 tons capacity stand for its load, and 5c per minute for a 5-ton auto truck. After that we built a loading hopper.

Canvas covers on the trucks are very good at all times, and especially in chilly weather when the crust of the mixture would otherwise become too stiff for proper raking. They should be so arranged that there is a 3 or 4-in. air space between the cover and the load; as this not only saves the cover, but also provides much better protection for the hot mixture.

One cent per inch yard mile is a good formula to remember when considering the cost of hauling asphalt paving mixtures. That is, it cost about 1c to haul enough mixture to lay 1 sq. yd. of asphalt pavement 1 in. thick and weighing about 100 lbs. on a street one mile from the mixing plant. Multiply 1c by the thickness in inches of the pavement, and that by the number of miles between the plant and the job. This is a rough and ready rule that should not be used as a basis for a bidding estimate, but it will help in quickly considering the comparative advantages of various available plant sites. It was the basis of a large asphalt hauling contract in New York City at a time when team hire was $6 a day.

The mixture should be dumped on the street on some spot outside of where any part of that particular load is to be laid, and all of it should be handled into place for raking by upturning the shovel at the place of deposit. Asphalt mixtures should not be cast long distances through the air to scatter over the foundation upon which they are to be placed. This is particularly true of those mixtures ranging from stone-filled sheet asphalt to bitulithic, in which such a casting about is likely to cause serious segregation.

Painting abutting surfaces of headers, curbs, manhole and handhole boxes, and so forth, is an old custom, and, we think, a very good one. The asphalt cement used for this purpose should be the same as that with which the mixture is made, and sufficient of it should be applied to be effective. If this detail of the work is worth doing at all it is worth doing well, and not in the skimpy careless way we so often witness on both contract and city work.

Sweep the foundation clean before placing the surface upon it. The investment is too great to be endangered by the neglect of a detail that costs so little. The roughened concrete surface that is preferred for asphalt paving requires some care in sweeping to make certain that all the small depressions are reasonably free from dust and dirt and loose material.

Laying asphalt in the rain is not as serious a matter as one would at first suppose. Experience has demonstrated that sections of pavement laid during quite heavy rainfalls have lasted quite as well as other sections placed when the weather was more favorable. This is not a plea for selecting rainy weather to lay asphalt surfaces, but for the costly mixture that is frequently hauled to the dump because some inexperienced engineer thinks a little moisture from above during the laying will cause an asphalt pavement to fail. We do not recommend laying in puddles of water, however, and every possible precaution should be taken to avoid bad weather.

Leveling and raking mixture requires more skill and attention than it usually gets. The raking process should be a kneading into place with the tines of the rake, so that about the same weight of mixture will cover each square inch of the foundation. Only in this way can a pavement be laid that will get equal compression under the roller and that will be of equal density throughout. We believe that the depressions in asphalt surfaces are frequently due to the further compression under traffic of those parts of the pavement that are spanned by the wide wheels of the asphalt roller at the time of laying. Certainly a roller riding on two dense knobs of mixture cannot properly compress the loose material between.

A true surface is essential in any good paving job, but especially is this necessary with asphalt, where every little fault may be seen so easily. Also, if there are no waves, there can be no rolls; and we often think that many surfaces displace partly because the original workmanship left the beginning of the wavey condition that later becomes so objectionable. A long straightedge, 10 ft. or more, constantly in use, will do much for any paving job.

The straight-line crown is used more extensively each year with all types of pavements, but it has special advantages in the case of asphalt, where there is so much objection to the little shallow puddles of water that form on the center of other crowns directly following a rainstorm. The purpose of the crown is to shed water, and it should be made to do that as effectively as possible, with the least necessary drop from a horizontal line. One-quarter of an inch to the foot is sufficient where a straight-line crown is used and the surfacing work well done.

Gutters should be asphalted to the curb. There is no reason for placing a cement or brick gutter on an asphalt street. Whether of asphalt, cement or brick, the gutter should rise at the rate of 1 in. to the foot, or better, for the first 2 or 3 ft. from the curb, in order to form a decided dish that will confine the water in a narrow stream against the curbing instead of permitting it to spread several feet therefrom. If the same care had been used in forming asphalt gutters with the proper rise that was used in laying cement or brick gutters on asphalt streets, no one would ever have thought it necessary to employ the other materials. The flat asphalt gutters of early construction have much for which to answer. Proper gutters can be formed and compressed with a tamper, and an experienced roller man can get into them effectively.

Asphalt to the street car rail wherever the street railway roadbed is good. Where it is poor, compel the company to make it what it should be, if possible. There is something very disfiguring about a ribbon of blocks along an outer rail on an asphalted street, and it is absolutely unnecessary in most cases. The way in which the asphalt promoters have persuaded cities to lay block pavements along car rails on asphalted streets has always appealed to me as diabolically clever. These men know that whatever is laid will go to pieces where the rail construction is bad, and, by shunting it over upon the other material, they avoid the discredit that would unavoidably, though unjustly, fall upon asphalt.

Maintenance

First construct then maintain your asphalt pavements. They should not require any repairs for a number of years after laying, except where some defect in construction comes to light; but whatever they do need they should get. Repairs should be carefully made, with perpendicular edges and properly painted joints. An asphalt patch should be left higher than the surrounding surface. If properly compressed in the making, there will be no sinkage under traffic that will require an allowance. Do not leave the surface higher than the car rails, manhole boxes, and so forth, against which it is laid. This has been tried and abandoned.

Three methods of maintenance for asphalt pavement surfaces should be considered. There is the simplest way, the cutting out of the defective section and replacing it with new mixture; the surface burner method has been used extensively, with fair results, and the remelting and remixing process has been successfully employed in many places. Needless to say, all three methods can be used to advantage in every large city, each being fitted to different conditions that are sure to confront the engineer.

The remelting and remixing of the old surfaces has always seemed to the author the one way that should be more carefully developed, with a view to the future maintenance of our asphalted streets. The reuse of the old material, which can be made as good as ever at little cost by remelting and remixing, with possibly a little added soft asphalt to rejuvenate it, will effect great economies in pavement maintenance over a period of years. The cost of new material is saved, and the expense of hauling the old surface to a dump is avoided. The trucks must return to the mixing plant, anyway, and they may as well carry a load of old asphalt surface as go back empty for the next load of mixture.

Asphalt is in its infancy as a paving material. Each year sees larger tonnages of it used for this purpose; and, as paving economy is more carefully studied by our public authorities, the very clear reasons for its extensive employment as a road surface material will be fully appreciated. The more universally it is used in any city, the more economically it can be handled.

American Military Roads

"Military Roads" are ordinarily supposed to mean roads like those of France which Napoleon and other French strategists built a century ago, as means of defensive mobilization of troops and supplies. In that old and narrow sense of the phrase, we have no military roads, certainly none whose location was governed by military consideration with a view to defense against a landing of hostile troops on our shores.

Many American Highways Are Military Roads

But warfare has changed and many of our American highways have become military roads in the strictest sense. The most expert judgment on this point is rendered by General Goethals of Panama Canal fame. Prior to our entrance into the war he was acting as state engineer of New Jersey, from which position he resigned to become Army Quartermaster General with direction of transportation. Before leaving New Jersey he submitted a remarkable report to the State Highway Commission, recommending that it concentrate all its available funds this year on New Jersey's military roads. He listed 14 such routes, which, if properly and uniformly developed and made acceptable for heavy army and civil motor truck traffic, would have great military value in facilitating truck transportation on a large scale and relieving the railroad congestion in hauling supplies to the camps, shipping bases and quartermasters' depots.

New Jersey Military Roads

All his recommendations were promptly accepted and the first year's levy of a direct tax which, it is estimated will total $15,000,000, in five years will be spent in strengthening the weak links in the roads which he singles out as of pressing military importance.

Four of the routes connect industrial regions with New York harbor while other routes are designed at the same time to relieve pressure on New York by facilitating use of other hitherto neglected shipping points. The quartermasters' depots in Philadelphia, the great ship-building plants near Newark, and the war manufacturing centers that are dotted all over the northern end of the state are taken into consideration. Better roads are also called for to the forts at Sandy Hook, the naval station at Cape May and the National army cantonments at Camp Dix and Camp Merritt. He pointed out that the only two approaches to the Hudson river were already over-burdened with traffic and suggested as regarding of the Palisades highway so that the steepest grade will be 7 per cent instead of the present 16 per cent.

Altogether the report is a masterpiece by a competent army officer who fully comprehended modern industrial and economic strategy, the great new feature of this war which makes it a contest of nations and industries as well as of armies. While no other state has made so comprehensive and expert a survey of the military feature of their road systems, there is evidence that other jurisdictions are alive to the situation and doing their loyal bit on a generous scale. The Goodrich touring bureau estimates that America will spend $263,096,610 on roads in 1918, which is 82% more than in the biggest previous year.

What Other States Are Planning

Oregon will spend five times as much as last year. It goes for trunk lines into large timber tracts from which must come the timber for aeroplanes and wooden ships. Arkansas has raised its appropriation from $4,000,000 to $12,000,000. Texas and Oklahoma are making high expenditures, the effect of which will be to facilitate activities in great oil and farming regions. Iowa spent $15,000,000 last year and will do it again, extending or improving 6,000 miles of highway. Wisconsin is developing a trunk system of roads tapping every town. In the northeastern states a new feature of importance is the methodical use of snowplows to keep the main industrial routes passable the year round for motor trucks. New York has just appropriated $1,000,000 specifically for improving the route from Buffalo to New York City, for inadequate maintenance and lack of snowplow work had impeded army motor transports from the West.

Some Backward Districts

On the other hand, the importance of the subject has not been uniformly appreciated everywhere and there are numerous sections, particularly in the industrial regions, where the national government is being seriously embarrassed by inability to do heavy motor-trucking as a means of getting past railroad congestion. The great movement of army trucks for foreign service on their own wheels from Detroit to the seaboard, for example, proved impracticable except by jumping in and making wholesale repairs and improvements at defective points on the route.

One impassable mile, one neglectful community along the road, is enough to keep a great artery out of use for our military and industrial mobilization. Every state and county ought to survey its situation from this angle and do its bit. Actual motor truck traffic is no criterion of a road's possible usefulness. The stream of trucks may be going a longer route at great cost and delay because a shorter route is in disrepair. Or goods may be going by railroad that could easily be carried on the highways if some backward township were not saving money and suspending road work "on account of the war!" Many a community is buying its quota of liberty bonds and at the same time ignorantly embarrassing valuable lines of communication, as effectively as if it had allowed the Kaiser's aeroplanes to demolish the roadways with bombs.

Testing Roads From Military Standpoint

The Goethals report (obtainable from the State Highway Commission at Trenton) contains enough explanation of various reasons for identifying certain roads as of military importance to furnish a fairly satisfactory guide to road authorities anywhere. Among the questions which the road commissioners of any jurisdiction should consider, are

1—Service to army camps.
2—Service to war plants and to open up sources of raw material such as lumber.
3—Service between cities where the local road is on a route that might be more freely used.
4—Alternative routes to relieve overburdened thoroughfares.
5—Reduction of grades that now compel lightening of loads.
6—Relief to congested railroads.
7—The suitability of the roadbed for heavy motor truck traffic.

Preparing For Heavy Motor Truck Traffic

How to make a road suitable for heavy motor truck traffic is vital at the present moment. Many miles of New Jersey highways have been built of plain macadam and although they were not designed to carry modern truck travel, much has been accomplished in carrying them through by tarviating or otherwise protecting the surface from the thundering motor truck and its ponderous loads.

Much more permanent work has been done using the old macadam as a base for a modern bituminous road. In the stress of war times the penetration type of bituminous macadam with a refined tar binder has been successfully adopted. Camp Dix at Wrightstown, N. J., with its miles of interior roadway and its approaches from the old state road show the possibilities of the penetration macadam for rapid construction under war conditions. All winter long the camp roads have resisted the pounding of Uncle Sam's heavy truck units with no appreciable wear or deterioration.

The Jersey problems are but samples. Other communities have them but seldom have they been so concretely and clearly stated as in the report of General Goethals.

Reinforced Concrete Pavement on the Baltimore Pike

The construction of the reinforced concrete pavement on the Baltimore Pike is now complete on three sections. The Baltimore Pike is known as Route 131 of the Pennsylvania State Highway System. The contracts which have been completed and which are now being executed were awarded when William D. Uhler was State Highway Engineer of Pennsyl-

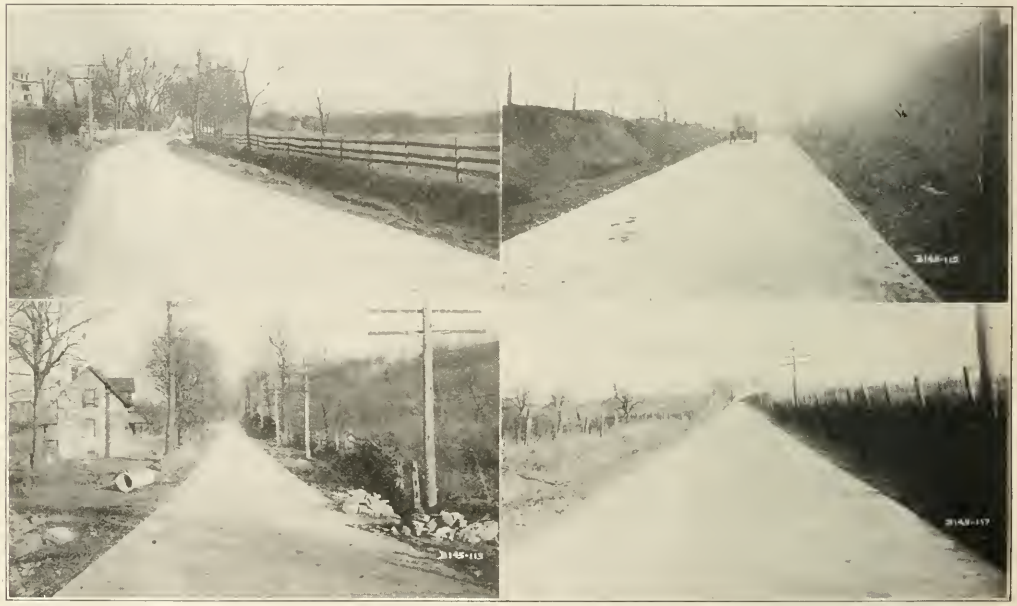
vania. Mr. Uhler is now serving the government in Washington in the capacity of lieutenant colonel of the Overland Motor Transportation Division.

Baltimore Pike work consists of 21 miles; contracts for which were let in six sections to the following contractors: The Juanita company, Philadelphia, Pa.; D. E. O'Connell & Sons, Avondale, Pa.; Sutton & Corson Construction Company, Ocean City, N. J.; Souder Construction Company, Lancaster, Pa.; Dwyer & Company, Philadelphia, Pa., and Neff & Horn Contracting Company, Slatington, Pa.

The three sections which have been completed are those under contract with the Juniata Company, Sutton & Corson and D. E. O'Connell. The Dwyer company, Neff & Horn and the Souder sections will be completed this year, it is expected.

The concrete on this pavement is a 1:2:3 mix, with a thickness of 6 ins. at the side of the road and 8 ins. at the center. The pavement is reinforced throughout with No. 25 Kahn road mesh. This is a stiff, rigid mesh manufactured by a cold-drawn process from one-piece metal plates. Uniformity in quality is one of its chief characteristics. It provides a taut reinforcement free from kinks and waves. It is delivered on the job in large flat sheets, thus obviating the annoyance of unrolling coils, cutting to length and holding down in place on the roadway. This mesh is laid with its long axis of the diamond across the width of the pavement. The mesh is laid approximately 2 ins. below the finished surface of the roadway.

Several views of the Baltimore Pike on the completed portions of the roadway are shown herewith.



VIEWS OF REINFORCED CONCRETE ROAD ON BALTIMORE PIKE IN PENNSYLVANIA.
Top: Views on Section 4 at Chadsford, Pa., and on Section 2 at Wawa, Pa. Bottom: Section 4 at Wawa and Section 3 at Mendenhal, Pa.

Procedure in the Use of Explosives on Road Maintenance Work With Specific Examples

By W. H. Dawson, Wilmington, Delaware

Throughout the spring of 1917 a certain 10 miles of road in Pennsylvania was in fair condition except for four or five sections which lacked drainage. For about one-eighth mile at each of these points the dirt bed of the road seemed to be almost bottomless. Travelers who were unable to get their cars through these places were forced to secure aid from nearby farms, and to pay a high rate for such services. The same condition had prevailed for years, and even showed itself during the wet June of 1916.

What One Man Accomplished With Explosives in Pennsylvania

A movement among those who used this road during the summer of 1917 resulted in the hiring of one man (only) to attempt to "improve" the conditions. An examination of the wet sections of the road showed not only the need for a less sticky surface, but what was more important, for deep drainage. Several springs fed stagnant ponds along the road, and the water seeped through under the track.

In casting about for a method of excavating the mile or more of ditch required, the workman tried plowing, but found he could not get a plow to run deep enough to lower the water level to any appreciable extent, or to drain it away sufficiently. Shoveling was out of the question. Blasting then was tried, and finally used for the entire job. One-half mile of 3-ft. ditch was thrown out by this man in 7 days.

The ditches blasted were mostly along the road, but at several points cut across the track, where the ground was hard and the excavation had to be 5 ft. deep. Still other ditches had to be made off from the road, to carry the water through patches of timber where it would empty into a creek. The ditches in each case were made deep and wide enough to gather and hold the water at a depth sufficient to prevent softening of the surface of the road. Wherever silt or gravel had gathered, or high ground interfered with the free discharge of the accumulated water into the creek, wide and deep channels were blasted. The workman surfaced most of the silt during the fall with shale blasted from nearby hillsides. The result of his work is that the entire 10 miles of road is hard and smooth in the spring of 1918, even in the face of weather conditions more trying than in 1917.

An Eastern Maryland Job

Another incident of a similar nature occurred in eastern Maryland. A typical "branch" stream of the section ran through a wide depression about 50 ft. deep. The road crossing this place had been cut down where it came over the top of the bank at one side, but the cut was narrow, and drainage water followed the wheel tracks. The clay was just porous enough to permit slow penetration, and the result for about 200 ft. was a quagmire which even a horse could not go through.

A young man who operated a farm in the vicinity, after failing to secure action from the county authorities, decided to remedy the trouble himself—of course with official permission. He blasted out ditches 4 ft. deep on both sides of the quagmire, going into the sides of the cut to do it. Within a few days the soft mud began to harden, and soon the road was passable and smooth.

For Individual Initiative

These incidents show what can be done with explosives. Travelers often wallow through mud-holes day after day, wasting time, taking the risk of getting stalled and of damaging their cars, when an hour or two spent in forcing a *workable method of remedying the trouble* to the attention of road officials, or in hiring a man or two to do the work at private expense, would provide a smooth track. Lack of funds and lack of men will be urged as reasons for delaying the repairs, but there is no excuse for permitting such delay to continue after a way is pointed out. In every neighborhood there are at least one or two men who can be hired to do the blasting, and in spite of war restrictions, there is not a county in the United States where dynamite cannot be procured.

How to Blast a Ditch

To blast a ditch requires a crow-bar for making holes, with possibly a soil auger and a sledge. In soft ground the bar is all that is needed. If stones are encountered the sledge will help. In stiff clay the auger sometimes will make them faster, particularly the bottom half of each hole. A tamping rod such as an old broomstick is also neecssary.

Before the war, the customary explosive for this purpose was nitroglycerine, powder or dynamite of high percentage. Experience has proven that low percentage ammonia powder will do this work as well, for two reasons. First, the latter costs only about half as much, and is more easily supplied, because nitroglycerine is demanded in ever-increasing quantities in the war. Second, the ammonia powder actually has proved that it will throw out the dirt better and dig deeper channels with the same depth of loading.

To use the farm powder, however, electric firing is essential. All charges in a series making up one shot, from 10 to 100 in number, must be fired instantaneously by an electric spark. To accomplish this firing, electric blasting caps must be used, the charges must be connected together with insulated copper wire, and the current must be applied from a blasting machine or light or power line.

Blasting Machines and Caps

All this is much more simple and inexpensive than it sounds. The blasting machines are not expensive, and are easily carried about. They nearly always are more convenient than light or power current, though electricity in that form can be used if it is available. Any electrical expert, or any powder company, should be able to give detailed instructions. The blasting machines require no particular skill in their operation. They are made for the use of the average laborer. The electric blasting caps are like ordinary blasting caps, except that they have small wires fastened in them. Connecting the series of charges to make a shot consists simply in twisting the ends of the wires tightly together. The electric firing removes the one objectionable feature of blasting ditches along roads—the danger of the blast to passing travelers. As the machine can be made to fire the blast at just the exact instant desired, as a gun may be fired by pulling the trigger, danger from misfires or hangfires is practically impossible.

One man can do a great deal of good in a few days by making use of these facilities. A well-drained earth road is not equal to a modern concrete highway, but it is possible at a good rate of speed at all times, and when the nation's life depends as much, perhaps, on conserving our time and energy, and getting our work done, as on saving wheat and pork and coal, the humble ditch made with a few shots of powder well may be a vital help.

Quantities and Cost of Cement Used in the California State Highways

By A. B. Fletcher, State Highway Engineer, Forum Bldg., Sacramento, California.

When the California Highway Commission was organized early in 1912 it made special endeavor, among other things, to obtain substantial reduction in the existing freight rates for all supplies and equipment; to contract at reduced prices with the owners of quarries and gravel deposits for large quantities of crushed rock and gravel, and to secure from the cement companies an agreement to make a wholesale price to the state for the required cement below the going market rate for that commodity, all such agreements to last during the life of the work.

The commission early arrived at an understanding with the transportation companies, which has lasted up to the present time and under which there has accrued a saving of several hundred thousand dollars to the state. Contracts were made with various rock and gravel companies at attractive prices, to continue during the construction of the state highways.

Agreement With Cement Companies

An attempt was made to contract with the cement compa-

VIEWS OF CONCRETE PAVEMENTS ON CALIFORNIA STATE HIGHWAYS.

nies for the cement required at a mill base rate, but the attempt failed. Finally, however, at a conference at which practically all of the cement companies were represented, it was decided that bids should be called for for the cement needed for each particular section of highway to be placed under contract, they to bid on the cement at the point of delivery (nearest freight station to point of use) and not at the mill, but they agreed orally that the price during the life of the work should not exceed the sum of $1.40 per barrel at the mill. The price for the sacks was to be added to the bid price with the usual rebate on the return of the sacks to the mill.

Until the spring of the year 1917 the cement companies kept their agreement absolutely, then the mill base rate was advanced in some cases to as high as $1.50 per barrel, and later further advances were made until at the present time some of the mills are charging $1.95 per barrel at the mill.

It was stated that the reason for the advance in price was because the cement companies considered the oral agreement to be nullified when the $18,000,000 bond fund, the first voted by the State of California, was exhausted. They would not grant the request of the commission that the oral agreement should be held to include the entire duration of the state highway construction period.

Prices Paid for Cement

The prices paid for the cement are interesting. During the active period when the agreement was adhered to fully (1912 to 1916 inclusive), the commission paid an average mill base price of about $1.33 per barrel. During the whole period, 1912 to April, 1918, the average mill base price paid for cement delivered was $1.345 per barrel but this average price will be greater when all the 1917 and 1918 purchases are delivered.

It speaks well for the cement companies of California that although the cement was rigidly inspected at the mill, at the commission's laboratory, and in the field, of the total delivery of nearly 1,750,000 barrels during the years 1912-1917, inclusive, not a single barrel could be condemned because of failure to comply with the specifications.

The accompanying table gives a recapitulation of analysis of cement purchases for the years 1912 to 1917, and a portion of 1918:

RECAPITULATION OF ANALYSES OF CEMENT PURCHASES FOR THE YEARS 1912 TO 1917, AND A PORTION OF 1918, DEPARTMENT OF ENGINEERING, CALIFORNIA HIGHWAY COMMISSION.

Year	Total Deliveries Barrels	Total Cost at Mills	Average Mill Base
1912	142,465.50	$ 176,683.24	$1.240
1913	242,514.50	317,376.36	1.309
1914	677,790.25	898,403.48	1.325
1915	355,005.50	485,267.31	1.367
1916	110,090.00	150,958.28	1.371
1917	220,794	321,064.61	1.454
1918	31,552	44,995.75	1.426
	1,780,211.75	$2,394,749.03	$1.345

WATER WORKS DESIGN AND CONSTRUCTION

Special Features of Improvements to Main Water Supply Lines of Bayonne, N. J.

By Nicholas S. Hill, Jr., of Hill & Ferguson, Consulting Engineers, 100 William St., New York, N. Y.

Recent improvements on the main water supply lines of the city of Bayonne, N. J., included several features, here described, which are of more than ordinary interest and magnitude. Some of these features are of unusual occurrence. Among the factors which influenced, in a large measure, both the design and construction of the improvements were:

The laying of a 30-in. pipe line on a right of way across the New Jersey Meadows, in portions of which the soil was too thick to permit operation of a derrick boat, but so soft that grillage had to be provided for derricks and traveling and even for workmen; the driving of a cut under 30 tracks of the Pennsylvania and Lackawanna railroads, several of which carried high-speed traffic, operating trains at times at three-minute intervals; the maintaining of all traffic uninterrupted, and the prosecution of the work of construction in such a manner as to provide at all times an adequate supply of water for the consumers.

Brief Outline of Improvements

The water supply for the city of Bayonne is brought from Little Falls, on the Passaic river, through the pipe lines of the East Jersey Water Company, to Arlington, N. J., thence through lines of the New York and New Jersey Water Company across the Kearny Meadows and along the easterly shores of the Hackensack river and Newark bay to the northerly line of the city, where it is delivered into the municipally owned distribution system.

The improvements here discussed were made on that portion of the lines extending from the north right-of-way boundary of the Lackawanna Railroad southerly to the north side of the Newark Plank Road, or Lincoln Highway. This section, prior to the commencement of the new work, consisted of two 20-in. cast iron Ward joint pipes under the tracks of the Lackawanna and the Pennsylvania railroads, a length of about 500 ft., and the remainder, a length of about 5,600 ft., two 30-in. steel lines. Of the last mentioned lines, the older, a riveted steel pipe, had been abandoned and the entire supply was being maintained through one line.

The plans for construction and repairs provided for a new 30-in. pipe for the full length of the improved section, for a second 30-in. pipe under the railroads, and for moving and replacing the existing 30-in. steel pipe then in service. A concrete culvert was designed to carry the pipes across the railroad properties in order to facilitate inspection and repairs as well as to protect the pipes.

Consideration of Durability Leads to Choice of Cast Iron Pipe

Preliminary investigations of the old pipe lines clearly indicated that one of the most important decisions to be reached was in the selection of the kind of pipe to be used for the new construction. The elevation at which the pipes were to be laid was practically determined by the grade of the proposed streets. It was possible to place the bottom of the pipes a few inches above mean high water, but, due to capillary action and rain water, the pipes at this elevation are subjected to alternate wetting and drying, with the tendency to hasten disintegration. Unfavorable soil conditions, due to the presence of swamp muck and a rubbish fill containing a large percentage of ashes and decaying matter, all pointed to the selection of the relatively thick cast iron pipe, because of its durability as compared with thin steel pipe. The decision finally reached resulted in the adoption of cast iron, and was due in part to a consideration of the question of cost. At the time this study was being made the steel market was rapidly rising, and while there was an upward trend to all prices of materials of con-

struction, the price of cast iron pipe lagged behind that of steel to such an extent as to bring the costs per foot of completed line of iron and steel so close as to make the selection of the most durable material a certainty.

Supporting the Pipe Lines on Piling

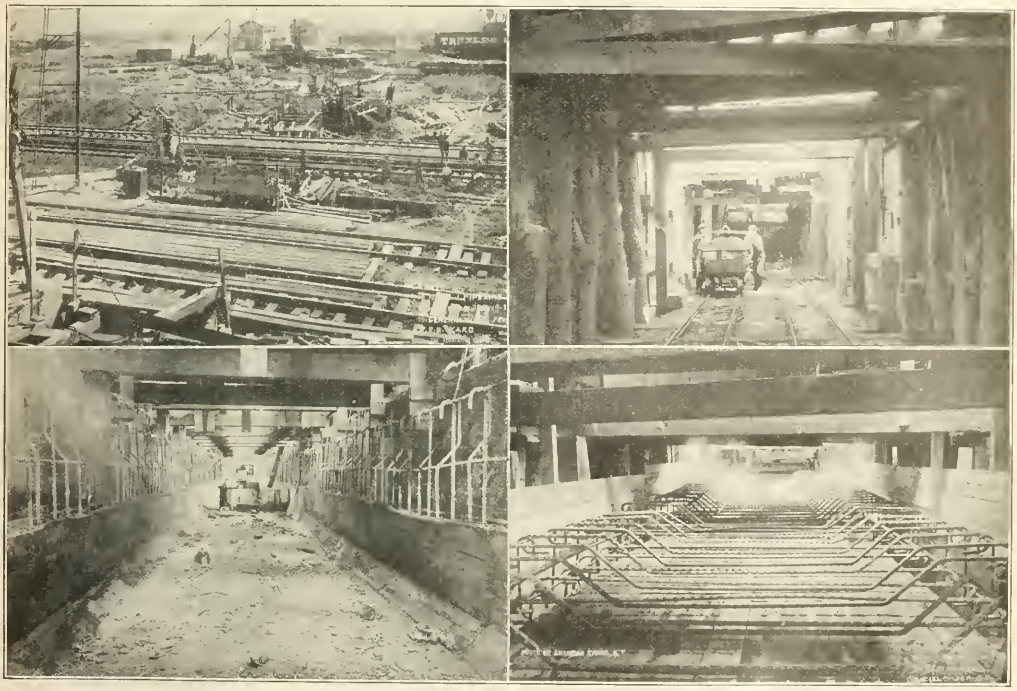
Having determined on the kind of pipe, the problem of supporting the lines was the next consideration. Several engineers who had but recently erected structures and laid railroad tracks in the vicinity of the proposed works were interviewed and their experiences relative to the subsurface conditions were obtained. Soundings were also made by prodding through the upper layers of muck, and the profile of the top of a hard sand and gravel layer was plotted. This was found to vary in depth below the elevation of the proposed pipes from 10 to 20 ft. Results of borings made for other purposes in the vicinity were obtained and some wash borings were made along the proposed culvert site. All of these investigations indicated that, in general, piles would furnish the best means of supporting the structure, and the original plans accordingly provided for this type of foundation.

Where the pipe lines were located in undeveloped meadow and where there would be no superimposed load on the pipes, supports were placed on 12-ft. centers and located near the bell end of the pipe. The ordinary pile and concrete cap bents were used for such locations. The concrete cap was made 5 ft. deep in order to bring the pile cut-off below low-water elevation. No cross-bracing was used, as the piles and caps in all cases were imbedded in the soil and the tendency toward lateral displacement was practically negligible.

Reinforced Concrete Mat Support

After the work had been started, a portion of the lines was relocated to conform to the proposed streets, and for this section the condition of loading was such as to require a different method of support. Several types of foundations were considered, with the final adoption of a reinforced concrete mat. The pipes were supported on this by means of concrete blocks or cradles placed on 4-ft. centers. The blocks held the pipe 1 ft. above the mat, so that sufficient working space could be maintained between the pipes and the mat. The pipe lines were located in the sidewalk space, where the superimposed load would never be very great, excepting at such points as road and sidetrack crossings. I-beam bridges were provided for all sidetrack crossings and bridges were designed for roadway crossings where heavy traffic was expected and where the cover for the pipes was shallow.

Where the pipe crossed railroad property, under existing fill, it was decided to omit pile foundations, as the ordinary surface muck had been thoroughly compacted or entirely forced outside of these areas by the weight of the railroad embankment. Where the culvert crossed the location of the proposed new tracks of the railroads, pile foundations were used. A timber floor was first placed on the piles in order to insure the proper placing of the reinforced concrete for the culvert.



VIEWS AT RAILROAD CROSSING OF NEW MAIN WATER SUPPLY LINES OF BAYONNE, NEW JERSEY.

Top: General View of the Culvert Construction Under Pennsylvania Railroad High Speed Tracks—Excavating for Culvert Under P. R. R. Yard Tracks. Pile Bents Supporting Tracks. Bottom Row: Culvert Bottom About Ready for Placing the Two 30-in. Pipe Lines—Reinforcing for Top of Culvert.

Designing the Culvert Under Railroad Tracks

The culvert as designed was decided upon after consideration of various types of protection. The ordinary concrete built-in place was estimated cheaper than either large diameter of cast iron seconds or large diameter of concrete pipe. As compared with the timber and railroad rail protection, the added cost of the concrete culvert was thought to be worth while in order to provide a means of inspection at all times.

The detail design of the culvert was governed somewhat by the requirements of the railroad companies, and the Lackawanna impact formula was used, in which Impact=S×300 (L+300), where S equals maximum stress developed and L equals length of span. The following loadings, which produced maximum stress, were used:

Case 1—An axle load of 78,000 lbs. on 7-ft. centers.

Case 2—An axle load of 65,000 lbs. on 5-ft. centers.

Case 3—16,250 lbs. per lineal foot of each track, distributed over a width of 10 ft.

The allowable working stresses, as specified by the railroads, were:

16,000 lbs. per sq. in. for steel in tension.

650 lbs. per sq. in. for concrete in compression.

Culvert Location and Section

The railroad tracks were located on two main levels, with a difference in elevation of about 12 ft. The low-level tracks were located on both sides of the yard tracks, existing and proposed, the latter occupying a space of about 500 ft. The elevation of the low-level tracks was such that the culvert crossing under them would be entirely below the water level in the meadows. It was decided, therefore, in order to avoid placing the culvert under the high-level tracks below the water line, to change the grade abruptly at both sides of the high-level fill, at which points the grade of the pipe was changed by means of special bends.

No special water-proofing was used in the construction of the culvert, as its length under the low-level tracks is short, and any dead water lying there could easily be removed by a small pump if necessary. The culvert section was made just large enough to allow for the passage of a man between the pipes and sufficient space for caulking on each side. This made the total width inside 8 ft. 8 ins. and the height was fixed at 5 ft.

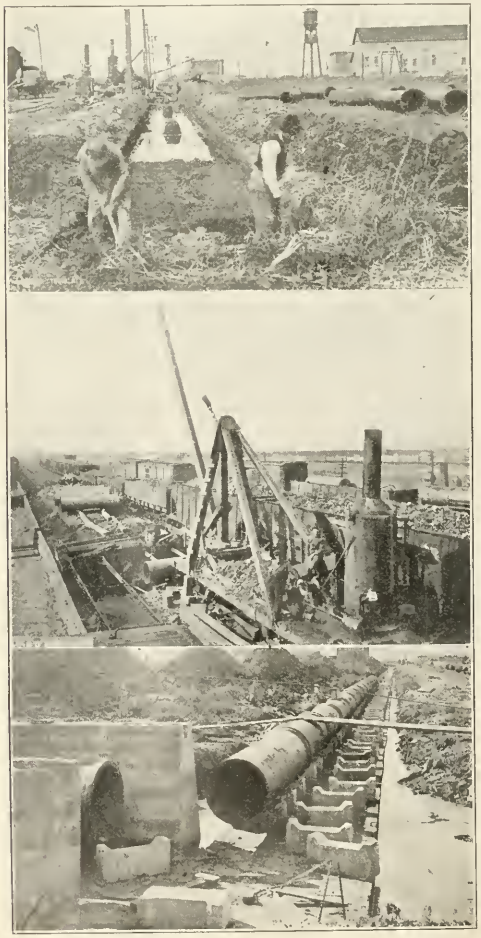
The work of construction naturally classified itself into two main divisions, namely, that under railroad tracks and that in undeveloped meadows or along existing roadways.

Construction Under Railrood Tracks

The construction under railroad tracks was largely under the supervision of the railroad officials. In the preliminary conferences it was not possible to get the railroad authorities to abandon any of the tracks during the process of construction, and methods for tunneling under the yard tracks were therefore considered. However, just before the work commenced, the railroad agreed to abandon every other pair of tracks through the yards, and it was then decided to use an ordinary derrick car to remove the excavated material, which was loaded onto gondola cars. The pair of tracks maintained in service were supported on pile and timber bents with timber stringers, all of which were placed by the railroad companies before the work of excavation was started. The trench was tight-sheeted both sides and the earth was excavated beneath the abandoned tracks and under a portion of the supported tracks. The culvert bottom and the lower half of the side wall was then built, the pipe placed in it and tested under hydraulic pressure. The top and upper half of the side walls were then placed. The backfill was next made, and as soon as the tracks could be relaid the construction equipment was moved over to the next two abandoned tracks and the same process of construction was repeated. No main traffic tracks were abandoned and no traffic interruptions were permissible. Slow-down orders were not issued excepting for a short time on one of the tracks, which showed some slight settlement.

Construction Work in Undeveloped Meadows

In general, traveling derricks were used for construction work in undeveloped meadows or along existing roadways. Tight sheeting was used for considerable distances along that portion of the trench where the meadows had been filled with sand dredged from adjacent rivers and which contained considerable ground water. Where the new construction was adjacent to the old pipe lines in service, piles were jetted into place.



VIEWS ON CONSTRUCTION OF NEW MAIN WATER SUPPLY LINES OF BAYONNE, N. J.

Top: Excavating Trench Through Swamp Muck. Traveling Derrick and Locomotive Boiler for Pumps Shown in Background. Center: Method of Handling Lengths of 30 in. Cast Iron Pipe at P. R. R. Crossing. Bottom: Construction Through Ash and Rubbish Fill. View Shows Bridge Abutments for Proposed Highway, Concrete Mat, and Concrete Cradle Blocks for Pipe Lines.

Importance of Duplicate Pumping Equipment

The Bellaire, Ohio, water purification plant has been in use in that city since 1915 and has produced very satisfactory results in so far as the quality of the filtered water is concerned. The equipment of the plant and of the water works pumping station operated in connection with it has never been entirely satisfactory, and there has always existed an uncertainty in regard to the ability of the system to continue in service.

On February 6, 1918, through failure of low-service pumping equipment, it became necessary to stop the operation of the filter plant and in order to maintain a water supply for

the city unfiltered Ohio river water was pumped to the distributing system. These conditions continued until February 23, 1918, when repairs were completed and the operation of the filter plant was resumed. During these 18 days the citizens of the city, who had become accustomed to the use of filtered water, were forced to depend upon a turbid and contaminated supply.

This instance serves well to illustrate the value of duplicate equipment and the necessity of maintaining all equipment connected with a water works system in a high state of efficiency, says the *Ohio Public Health Journal*. Serious depreciation of water works equipment cannot occur without a serious detriment to the community.

SEWER DESIGN AND CONSTRUCTION

Features of Proposed Sewerage Works for St. Augustine, Fla.

The proposed sewerage works of the City of St. Augustine, Florida, as recommended by Alvord & Burdick, consulting engineers, Chicago, have some novel features. The principal conclusions reached in the report of the engineers are as follows:

Summary of Recommendations

The population growth of St. Augustine has been comparatively slow, and it seems probable that the permanent population of St. Augustine proper will not exceed about 10,000 people by 1925, with a winter population at the same time of 20,000.

On account of the variation in the number of people in St. Augustine during the various seasons, there will be corresponding variations in the quantity of sewage. The sewers must be designed for the maximum flow conditions.

In our sewer design we have adopted a maximum domestic sewage rate of 30 gals. per day per foot of sewer. This is based upon an average density of population of five people to each 50 ft. lot, with an average water consumption of 100 gals. per capita per day, and a maximum rate 50% greater than the average rate.

In addition to the domestic sewage, we have provided sewer capacity to carry infiltration in the amount of 25,000 gals. daily per mile of sewer. Although many of the sewers will be laid in running sand and water, it is believed that using special-joint materials and precautions in laying, the allowance of 25,000 gals. per mile is ample.

The entire area within the present City of St. Augustine may be best sewered by dividing the city into 13 districts, seven of which have outlets discharging into the San Sebastian river and the remaining number into the Matanzas river. It is estimated that the cost of constructing a complete new sewer system, embracing all of the area within the present City of St. Augustine, would be $150,000.

Our investigation has led us to conclude that the sanitary sewers now in use in St. Augustine should be replaced. The cost of maintenance on the existing sewers is greater than the interest on the investment in a new sewer system such as is herein proposed.

Vitrified pipe with special water tight bituminous joint materials should be used in the future for sanitary sewer construction in place of cast iron soil pipe, which has thus far been almost universally used in St. Augustine for this class of work.

On account of the peculiar topography of the City of St. Augustine, it is impossible to sewer the central part of the city by gravity, and, accordingly, three automatic controlled electrically operated pumping stations will be required in that area. All of the areas outside of the present city limits can be served by gravity sewers.

The sewage of the City of St. Augustine and its environs can be best disposed of by dilution and diffusion through a considerable number of submerged outlets discharging into the San Sebastian and Matanzas rivers. In view of the relatively high tidal variation at St. Augustine and the resulting high velocities of flow in the San Sebastian and Matanzas rivers, this method of disposal will be adequate for a long time, if not indefinitely.

Present Cast Iron Pipe Sewers

The city is now served with a large number of private sewers, there being 36 outlets into Matanzas Bay, and 8 outlets into the San Sebastian River.

These sanitary sewers are all privately owned, and all laid on very flat grades, and of cast iron soil pipe. The grades are so flat that even when the sewers were new, the velocities were not sufficiently high to make the sewers self-cleansing. Accordingly, from time to time, deposits have formed in the sewers and they have required a great deal of maintenance expense. In addition to the trouble arising from the flat grades, an incrustation is produced in the cast iron soil pipe by the large amount of sulphuric acid, chlorine, and hydrogen sulphide present in the St. Augustine water supply, which combine chemically with the iron pipe. In order to ascertain how much this had affected the sanitary sewers and their carrying capacities, the engineers had a number of the sewers uncovered and broken into. In all cases there was found an annular incrustation averaging about 1 in. in thickness, which was hard and black, and had a sort of mossy or earthy odor. The deposit is too hard to be removed by any flushing after it has once formed within the sewers.

In most cases the cast iron soil pipe shell was almost entirely eaten away by the chemical combination of the iron with the acids in the water, and the sewage. The incrustation then furnished the pipe walls through which the sewage was being conducted and when that was broken, no sewer remained.

The soil pipe sewers give evidence of having been repaired in many places, and this result of the engineers' inspection was substantiated by inquiry of Mr. Henderson, city engineer, and the local plumbers, all of whom stated that the present soil pipe sewers were a source of continual maintenance expense to the owners, and a corresponding source of revenue to the plumbers.

Based upon their inspection on the ground, and all the data they were able to gather while in St. Augustine, it is the opinion of the engineers that very few, if any, of the present private sewers can be profitably made a part of an adequate sewer system for the City of St. Augustine. All the evidence gathered was to the effect that the cost of maintenance of these sewers would be greater than the interest on the investment in the new sewers proposed. Accordingly, in their design of an adequate sanitary sewer system for the

City of St. Augustine, the engineers gave no credit for existing sewers.

Possible Necessity for Future Disposal of Sewage

At St. Augustine the normal tidal variation is about 4 ft. 2 ins. The city is bordered on both sides by rivers in which the tide runs at relatively high velocities, which will serve to carry sewage away from sewer outlets and effect a thorough diffusion of the sewage with the tidal waters. The water fronts of the city are not suitable for bathing purposes, and accordingly, sewage properly diffused so that its presence is not apparent to the eye, is not otherwise objectionable.

On account of this, it is the opinion of the engineers that the best method of disposing of the sewage of St. Augustine is by dilution through a number of outlets so constructed that the sewage is discharged under the water surface at all times. A relatively large number of outlets are preferable to a smaller number of outlets, on account of the fact that with the larger number there is less sewage discharged into the tidal waters at any one point, and accordingly, the sewage is more thoroughly diffused in the diluting water. There is less likelihood of any nuisance resulting, or of any of the effects of the sewage being apparent on the water surface. With sewer outlets correctly designed and constructed, the dilution afforded by the tidal flow in the Matanzas and San Sebastian rivers, will adequately take care of the sewage of St. Augustine for the present and for a long time in the future, if not indefinitely.

Entrance of Roots Through Pipe Joints

In practically all of the south Atlantic coast cities, a great deal of trouble has been experienced with the use of vitrified tile pipe on account of the entrance of Palmetto roots through the joints. Small roots get into the sewer through the joints and after entering the sewer have a rapid growth. In many instances they have entirely choked the sewer section. This root trouble has been experienced in the St. Augustine storm sewers and the knowledge of the danger of sewer obstruction from roots without the knowledge of how to make tight joints and thus obviate the trouble is the primary reason for the adoption of cast iron soil pipe rather than vitrified clay pipe for sanitary sewers in St. Augustine.

The root trouble can be overcome, and has been overcome in a great many places by the use of tight joints made of jute, and some joint compound similar to the G. K. compound made by the Atlas Company of Lincoln, N. J., and the S. P. C. compound made by the Standard Paint Company or the "sulphur sand" joint more commonly used along the Atlantic coast further north.

Types of Construction Recommended

From a study of the effects of the St. Augustine water supply and sewage upon cast iron soil pipe, cast iron water pipe and vitrified sewer pipe, supplemented by a study of the analyses of the water, it was the conclusion of the engineer that the material which should be used at St. Augustine for the new sanitary sewer system is vitrified salt-glazed clay pipe. The sewage apparently has no appreciable effect upon this material.

The engineers further recommend that all joints be made by thoroughly caulking with yarn and finished with some joint compound similar to "sulphur sand" or the G. K. Compound, or the S. P. C. Compound. Any of these materials, carefully used, will serve to minimize the amount of infiltration which will have to be taken care of by the sewers and the pumping stations, and will effectually prevent the entrance of roots into the sewers through the joints.

As the nature of the topography is such that in many places the velocities of flow in the sewers must be low, it was recommended that automatic flush tanks be installed at the upper ends of many of the laterals. These flush tanks should flush the sewers about once each day and will assist in keeping the sewers free of deposits.

Recommended Plan of Sanitary Sewers for the Present City of St. Augustine

The entire area of the city has been divided into 13 districts, 9 of which drain to San Sebastian and Matanzas rivers entirely by gravity, and 4 of which are drained partly by gravity and partly by pumping. There will be four pumping stations, each of which will be electrically operated, and the pumps and motors automatically float controlled.

Each pumping station will be of concrete and provided with a storage reservoir on the suction side of the pumps. The provision for storage is very essential where small quantities of sewage are to be pumped, as, by the use of storage, larger pumps, which are less liable to clog, may be used intermittently with a greater economy than small pumps in operation continuously.

The pumping units will be in duplicate and so arranged that either pump may be removed for repairs or cleaning without interfering with the operation of the second unit or the station. If, from any cause, both pumps should be shut down, or the automatic control fail to work, a by-pass will be provided, so that when the sewage rises to the elevation of the discharge gravity sewer, it will flow into that line until such time as the pumps again operate and lower the level in the suction storage reservoir. Each pump should be of such capacity that it will take care of the entire sewage reaching the station when operated intermittently, probably not more than about half of the time.

The intermittent operation of the pumps will serve to flush the main sewer line, into which the pumps discharge, somewhat in the same manner as is done by the automatic flush tanks.

The report here considered was prepared by Alvord & Burdick for the American Park Builders of Chicago, who had the contract for a comprehensive city planning report to the city of St. Augustine.

Specifications for Testing Sewer Connections and House Drains

The following specifications for testing sewer connections and house drains were prepared by DeWitt H. Wyatt, sanitary engineer, 1672 Summit street, Columbus, O., in consultation with William C. Groenniger, Ohio state plumbing inspector and president of the American Sanitary Engineering Society:

Cleanouts and Test Openings

Anticipating the making of the tests specified, cleanouts and test openings are specified as follows:

At the foot or base of all vertical lines of soil and waste pipes, at the end of each horizontal line, one made with a full size "Y" branch just inside of the foundation wall, near the house drain and the house sewer connection, and at intermediate points not to exceed 50 ft.

Test openings should also be provided in the house sewer at points near the branch in the street sewer and at the property line.

Nature of Tests

All piping of the drainage or plumbing system shall be given two tests by the plumber in charge; first, the roughing in with a water, smoke or air test; second, with smoke, both to be made in the presence of the proper authorities.

Material and Order of Test

The material and labor for the tests shall be furnished by the plumber. The tests shall be made in the following order: First, the house sewer and house drain; second, the soil and waste vents and all vertical piping; third, the final on the whole system. The first and second named tests may be combined, but the second shall not be made until after the first.

House Sewers and House Drains

The house sewer and house drain shall be tested with the water, smoke or air test. The water test shall have a 10-ft. head of water and the smoke and air test a 5-lb. pressure.

Conductor Pipes

Conductor pipes and their roof connections within the walls of the building, or conductor branches on the outside system where such branches connect with the house drains or are less than 3 ft. from the walls of the building, shall be tested by the water test.

Covering of Work

No part of the plumbing or drainage system shall be covered until it has been inspected and tested and approved by the architects or engineers and the proper city or state officials.

Water and Air Test

Soil, waste, vent and inside conductor pipe stacks, and all work known as "rough" work between the house drain connections to points above the finished floors and beyond the finished face of walls and partitions, shall be tested with water, air or smoke when the whole stack is completed and topped out above the roof.

The water test shall be applied by inserting a test plug in the cleanout or test opening at the base of the stacks and all openings in the piping, and completely filling the system with water, the water columns to be left standing at least 15 minutes. If the water level remains constant such time, the system shall have been acceptably tested.

When water is not available, or when there is danger of freezing, the air or smoke test shall be used, with a pressure of 5 lbs., using an open mercury gauge with 10 in. of mercury.

Final Test

When the plumbing and drainage system is completed and the water is turned on and the traps filled, it shall be inspected and tested with the smoke test.

Smoke Test

The drainage system of the buildings and all soil, waste and vent pipe stacks installed shall be given their final tests with smoke.

The smoke machine shall be connected to any suitable opening or outlet in the system, and when the system is completely filled with dense, pungent smoke and the openings emit smoke, they shall be closed and an air pressure equivalent to a 1-in. water column shall be applied and left standing at least 10 minutes. If there is no leakage or forcing of trap seals, the system shall be deemed air or gas-tight. But nothing in this section shall be so construed as to prevent the removal of any cleanout or unsealing of trap to ascertain if the smoke has reached all parts of the system.

Successful Mechanical Cleaning of Sewers at Goshen, Ind.

In the city of Goshen, Ind., the roots from certain large, handsome shade trees had found their way to a nearby pipe sewer and had entered the joints of the sewer, thus partially clogging the structure and impeding the flow. The trees were sawed off close to the ground and holes were bored into the stumps and acid was introduced into these holes in an effort to kill the growth of the roots, and so stop the interference with the functioning in the sewer. This attempt was unsuccessful, as the acid failed to kill the root growth, which continued until the sewer flow was entirely stopped.

A Turbine sewer cleaner was then obtained, and easily and inexpensively removed the root growth from the sewer, although, of course, it was too late to save the shade trees which had been sacrificed. The accompanying illustration shows the accumulation of roots removed from this particular sewer.

The windlass which draws the Turbine pipe cleaner, is manufactured and handled by The Turbine Sewer Machine Company, of Milwaukee, Wis., is shown in the view resting on the manhole top. This windlass draws the cleaner from manhole to manhole through the sewer. A hose attached to a convenient fire hydrant is used for flushing out the foreign

ROOTS REMOVED FROM GOSHEN, IND., SEWER WITH TURBINE SEWER CLEANER. ROOTS HAD COMPLETELY STOPPED FLOW AFTER TREES WERE CUT DOWN.

matter loosened by the passage of the cleaner. Cleaners of this type have been successfully employed by many cities throughout the country in removing accumulations of various types of foreign materials from sewer interiors. With this machine sewers are cleaned on contract, or the apparatus is sold outright to the city.

Features of New Outfall Sewer of City of Los Angeles

Conditions resulting from the discharge of sewage in the Pacific ocean have been improved since the installation of the new out-fall sewer and discharge pier in the city of Los Angeles at Hyperion. This is not a finished engineering problem, however, as the city will necessarily install sewage treatment works to aid natural dilution in treating the sewage of Los Angeles. This out-fall and discharge pier are parts of the general sewage disposal works contemplated for the city, and were completed in March of this year at a cost of $226,000. The construction work was done by force account. The pier and out-fall sewer comprises a masonry conduit about 4,300 ft. long, tunneled through sand hills adjacent to the beach, and about 2,000 ft. of wood stave pipe carried out into the ocean on a timber pier.

The entire sewage disposal project will cost about 1,500,000 and will serve a population of about 1,000,000 people.

Old Out-fall Sewer and Discharge Pier

The new out-fall sewer intercepts the sewage at a point east of the sand hills mentioned and connects with the old central out-fall sewer of the city. This construction was made necessary by the deteriorated condition of the old central out-fall and the discharge pier. The old works will be retained for emergency uses. Since the new out-fall sewer has been in use, opportunity has been had for inspecting the old line, and it has been found that the masonry lining of the old sewer had deteriorated, the bricks and mortar being badly worn and the strength of the masonry impaired. The new out-fall also has greater capacity than the old.

The old discharge pier extends a distance of 970 ft. into the ocean and carries a wood stave pipe about 34 in. in diameter. This wood pipe will be filled with water occasionally to keep it in working condition until the city no longer needs it. Com-

paring the new and old piers, the new pier is twice the length of the old and has a depth of water at its ocean end of about 30 ft. From it sewage is discharged through five outlets, extending 18 ft. below the average tidewater elevation. At present the maximum sewage discharge is about 50,000,000 gals. per day.

Conditions at Out-fall

There are no ocean currents at the point of discharge to assist in the dilution of the sewage. Because of this fact, the rate of diffusion is slow and the contaminated area is easily identified by the observer. Odors still arise from this locality, and neighboring beach cities complain of the pollution of the air, so that the treatment plant already mentioned must necessarily be constructed later on.

The sewage treatment plant which has been planned to supplement the out-fall sewer and discharge pier comprises a series of Imhoff tanks and sludge beds on the ocean side of the sand hills. These works will cover an area of about 20 acres.

Elements of Design

Work on the new out-fall pier and discharge pier was commenced in September of 1916. The first work done was on the Bellview avenue out-fall sewer. The total length of the improvement is 6,248 ft. and consists of 4,293 ft. of conduit and 1,955 ft. of wood stave pipe. The total cost was $226,063. The conduit portion of the Bellview avenue out-fall sewer consists of brick and concrete masonry and is divided into two sizes: 5 ft. 9 in. and 4 ft. 4 in., circular sections. These two sizes are connected with a length of 84 ft. of 42-in. cast iron pipe. The average depth of the conduit, excepting at its east end, and at one other point, is about 100 ft. below the top of the sand hills.

Work on the tunnel excavation was started at the west portal. Later on, the tunnel was driven simultaneously from both ends. The excavation work covered a period of 10 months. The soil traversed was loose sand, and the average progress made was 9 ft. per day per opening.

Cost Data

The average cost per foot of the tunnel was $14.90. The cost per cubic yard of material excavated was $2.70, of which $1.47 was for labor, teams and foremen, and $1.01 for timber and lumber. Work on the air-shaft cost $3.55 per vertical ft. and on open cuts cost 50c per cubic yard. Laborers were paid from $2.50 to $3.00 per day, and team and driver $5 per day.

As soon as the tunnel work was finished, the construction of the conduit was begun. A length of 3,728 ft. of conduit has a diameter of 5 ft. 9 ins. This section comprises an inner circle of brick surrounded by an invert of concrete and a 2-ring brick arch. It cost $15.81 per lineal foot of conduit. The cost of the brick invert was $23.75 per 1,000 brick in place, of which $13.04 was for the material. Concrete work surrounding the brick invert cost $7.42 per cu. yd. The brick work in the arch cost $32.37 per 1,000 brick. A plaster coat ½ in. thick was spread over the invert, and cost 39c per ft. of conduit, or about 4c per sq. ft. Labor on the conduit cost from $2.75 to $3.50 per day, and skilled labor, like carpenters, blacksmiths and electricians, were paid $4 a day, and masons $6. The cost of cement varied from $1.52 to $1.89 at the factory. Crushed stone and sand averaged 80c per ton at the site of the work, and the brick cost $8.40 per 1,000 at the job.

Between the new sewage pier and the larger size conduit the section of the sewer is 4 ft. 4 in. in diameter, except for the 42-in. cast iron pipe section already mentioned. The cast-iron pipe section cost about $22 per ft. in place. The 4 ft. 4 in. conduit is under pressure and is of reinforced concrete construction, while its inner ring is of brick. This brick is a special vitrified brick, selected to present the maximum resistance to erosion and wear. The cost of this brick ring in place was $68.79 per 1,000 brick, of which the material alone cost $34.91 per 1,000.

At the outer end of the sewer conduit, the sewage is carried from a point near the high tide right out into the ocean through the 52-in. wood stave pipe line laid on the pier for a distance of 1,955 ft. This pier, which is practically level, cost $55,717. The fall of this pipe line is only one foot in its entire length. The pier cost $28.50 per lineal ft., of which $7.33 was for labor and $12.05 for piling. The piling cost from 51c to 79c per ft. of piling. Piles 75 ft. long were used at the outer end of the structure. The wood pipe cost $9.75 per lineal foot. The pipe staves cost $65 per 1,000 ft. board measure. The total cost of the pier and pipe line was $38.33 per lineal ft.

WATER PURIFICATION AND SEWAGE TREATMENT

Design and Construction of New Mechanical Water Filtration Plant at Oshkosh, Wis.

By T. B. Jorgensen, Resident Engineer, Oshkosh, Wis.

In October, 1913, the city of Oshkosh, with a population of between 30,000 and 35,000 inhabitants, located on the west short of Lake Winnebago, Wisconsin, acquired the city water works, which previously had been operated by a private company. In line with other improvements the city engaged Col. Henry A. Allen of Chicago as their consulting engineer to design and prepare specifications for a new water purification plant.

Contracts

The work in constructing the plant was divided in four separate contracts: 1. Structure; 2. Appliances and accessories; 3. Elevated steel tank, and 4. Cover to present water reservoir.

The filtration plant is of the rapid sand filter type of a capacity of 6,000,000 gallons per 24 hours with provisions for a future increase to 8,000,000 gallons.

The general layout of the plant is so designed as to make a complete symmetrical installation when the future pumping station is added to the new filtration plant. The city will require a new pumping station within a few years. The plant has a beautiful location on an open square on the lake shore adjacent to one of the city parks.

The construction work was started April 1, 1916, and contract for the structure was let to Larsen Construction Co., a local concern. The filter appliance contract was let to Roberts Filter Mfg. Co., of Philadelphia, Pa. The contract for the elevated tank was let to Wausau Iron Works, Wausau, Wis.

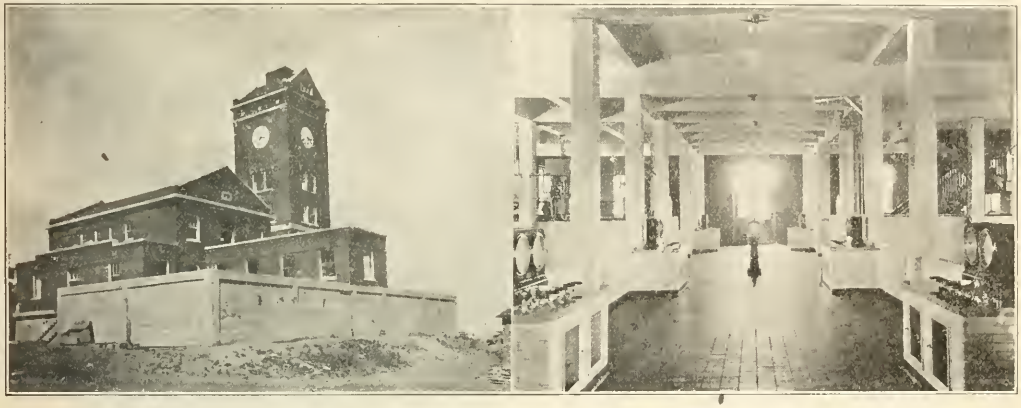
The water containing part of the structure is constructed of reinforced concrete, while the balance of the structure is made of pressed and wire-cut brick.

Elements of the Plant

The plant consists of a 3-hrs. sedimentation basin occupying the south side of the plant and 6 filter beds of a capacity of 1,000,000 gallons per 24 hrs. each; three located on each side of a roomy pipe gallery.

The tower, which is located in front of the filter structure on the east side, consists of a steel structure supporting a steel tank of a capacity of 50,000 gallons. This tower is entirely enclosed in brick work harmonizing with the balance of the structure, with a design of architecture to correspond with the entire structure. About the elevation of the tank is located four 8-ft. diameter clocks, which are illuminated at night.

The purpose of the elevated tank is to furnish water for washing the filters under a pressure of about 40 lbs. per sq. in. It is filled from the pressure main through a 3-in. pipe, which is again reduced and distributed to each filter bed.



EXTERIOR VIEW OF PLANT AND VIEW OF OPERATING GALLERY, NEW WATER FILTRATION PLANT AT OSHKOSH.

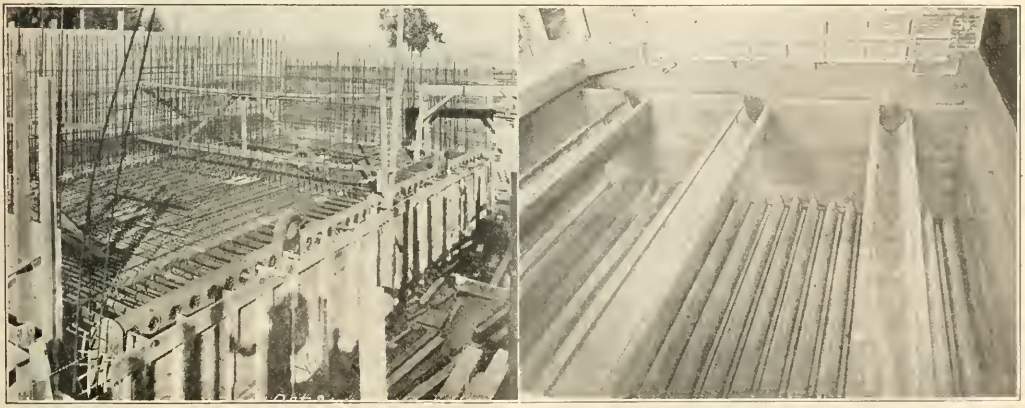
Course of Water in Passing Through Plant

The water enters the plant through two 24-in. intakes; one of which is now being constructed. The other intake is the old intake which is connected to the new plant. This extends about 900 ft. into the lake, while the new intake extends out 1,200 ft. These intakes discharge by gravity into an intake well, which is divided off into compartments, with a 24-in. sluice-gate in the partition wall which may be closed when it is desired to clean one intake well.

Aeration

From this well the water is pumped into the raw water main by means of two 2,500,000 gallon Manistee Iron Works' centrifugal pump units operated by two 25 H. P. electric squirrel-cage motors. These are again controlled by an automatic starter operated by two float switches located in the sedimentation basin, and accessible from the operating floor. This makes the supply of water to the plant entirely automatic and eliminates any chances of neglect by the operators. Before entering the sedimentation basin the raw water is discharged into the first and second aerating tanks, in each of which are located four aerating devices of Col. Henry A. Allen's patent. Between the two aerating chambers are located four vortex whirls whose purpose is to separate any heavy, suspended matter there by furnishing a clearer water for the sedimentation basin. At the discharge of the vortex whirls are connected four meters—Kreutzberg Volumetric type—which again control a chemical proportional feed device for the aluminum sulphate solution, which is discharged into the first aerating chamber and is thoroughly mixed with the water in the vortex whirls, in which the first aerators are discharged. The second aerators are discharged directly into the sedimentation basin.

The sedimentation basin is divided transversely in two separate tanks, connected by four 24-in. sluice gates, which



VIEWS OF STRAINER SYSTEM, NEW WATER FILTRATION PLANT AT OSHKOSH, WIS.
Left: Cast Iron Headers Put in Place Preparatory to Pouring Balance of Concrete Wall Enclosing Filter Bed. Right: Strainer Tubes in Place in Bottom of Filter Previous to Placing Filter Sand and Gravel. Strainers Can be Removed Without Disturbing the Filter Sand, Once in Place, by Pulling Tubes out Through Header into Pipe Gallery.

in normal run are kept open, and closed when cleaning one of the basins is found necessary.

A concrete baffle wall runs longitudinally along the center of the two basins about 12 ft. from the end walls, thereby giving a circular motion to the water from the time it enters the basin until it discharges into the 20-in. settled-water mains ,which again distribute the water to each of the six filters.

The Strainer System

The filter beds are equipped with a strainer system of Col. Henry A. Allen's patent. This consists of 20 2½-in. brass strainer tubes, placed 1 ft. apart in V-shaped valleys, constructed in the filter-bed floor. These strainers are perforated and collected into a cast iron header located in the concrete wall. To this header is connected the settled-water influent and the filtered water effluent.

The discharge of the waste water is carried into a concrete tank which is again drained to the lake at convenience, for the reason that a very small fall between the waste main and the lake could be obtained.

The problem of draining the sedimentation basin was also made difficult for the same reason and considering that the floor of this basin is below lake level. This was taken care of in the following manner:

In the floor of the basin there was concreted a 12-in cast iron drain pipe with a 12-in. sludge valve closing the inlets to the drain from the floor. This drain discharges into a sump on the outside of the basin and from these discharges tank. From this sump it is lifted up and discharged into the waste water tank by a vertical motor driven centrifugal pump unit.

Operating Gallery

The operating gallery is beautifully mounted and up-to-date, being equipped with marble operating tables on which are mounted "Loss of Head" gauges and rate controls operated by a venturi meter on each effluent line from each filter bed.

All valves which are in continuous use, are hydraulically operated. A pleasing feature is the white enameled brick railing built in conjunction with the operating tables, which adds greatly to the neat and sanitary appearance.

On the second floor is located the laboratory, toilet and locker room and aluminum tanks and storage for alum. The laboratory is completely equipped and beautifully mounted, the toilet and shower room is equipped with marble walls and partitions and red tile floors.

The city is having plans made for planting the grounds around the plant for shrubbery and lawns to harmonize with that of the adjoining park.

The writer was in charge of the construction work from the beginning up to the present time. We are now remodeling the reservoirs and working on the new intake. The writer designed the greater part of the concrete for this plant.

The Control of Stream Pollution—A Problem in Economics

By Earle B. Phelps, U. S. Public Health Service, Washington, D. C., Consulting Sanitary Engineer, International Joint Commission

The art of sewage and industrial waste treatment has advanced to such a point that it is now possible to discuss upon sound economic principles the troublesome question of general policies for the protection of streams against pollution. It is in no sense implied that perfection has been reached or that further important developments need not be looked for; and it is fully recognized that each improvement in methods necessarily shifts the entire economic balance. The general fact, however, remains that stream pollution is controllable within reasonable limits, and that the real problem of the moment is not how to prevent pollution, but where, when and to what extent is prevention called for.

The time has passed for the advocacy of streams of pristine purity, although this fact has not yet been fully recognized by legislatures. The time has likewise passed when the deliberate destruction of stream resources may be continued for private gain, under the guise of necessity or of inherent right. This is an age of conservation, and conservation of stream resources means the maximum economic development and use of all the various valuable functions of the stream.

Conflicting Uses of Streams

Our inland waterways are capable of a variety of uses, some of preponderating, some of minor, importance. These uses are often in natural conflict, so that the development of one may interfere with or even prevent the continuance of another. Water supply and waste disposal are examples of two such conflicting uses. The situation frequently arises in which the same stream must be used for both purposes and both are essential. Such conflicting and apparently incompatible uses of water obviously cannot be permitted without restriction and control, and even then they are impossible except through the interposition of remedial or protective works. Under proper control, however, an upper riparian community may discharge its community wastes into the water supply of a lower community, if there be interposed between the two, sewage treatment works or water purification works, or both. Similarly vessels navigating the Great Lakes may imperil the water supplies of the lake cities, but this danger may be entirely eliminated by proper protective measures upon the vessels.

Extremes in Legislation

The control of these matters has hitherto been a function of the states, and, although the problem of control involves a most careful balancing of public and private rights in a natural resource of inestimable value, the legislation that has been enacted shows for the most part no appreciation of its magnitude or complexity. On the one side we find enactments of the utmost severity, which are incapable of proper enforcement, or which would, if enforced, lead to an unnecessary expenditure of public funds. At the other extreme, some states have permitted stream pollution to reach a point where the resulting destruction of economic values is in no way justified by the public or private gain that is made possible thereby.

Shortcomings of Present Stream Control Measures

The shortcomings of the present situation as regards stream control are manifold, but they are in large measure traceable to one fact. Stream pollution laws have been enacted or proposed laws refused enactment, not on the basis of a scientific inquiry into the requirements of the case, but to meet the needs of a single kind of use. In general the public health needs and interests have been held paramount, and rightly so, but the control of stream pollution is a matter distinctly broader than its public health aspects, however important these may be, and it cannot properly be exercised as a public health function merely. To base stream pollution laws entirely upon the public health interests, or, what is worse, upon a misconception of what the true public health interests are, is insufficient and unsatisfactory. It is in the same category, but far more disastrous, to resort to a test of force between the public health and the industrial interests as to whether or not there shall be any control at all.

Proper Basis for Stream Protection

The only proper basis for a policy of stream protection is the principle of the conservation of stream resources, or the maximum beneficial use of the stream. The application of this policy involves a study of all the various uses of the stream and of the value of each. From a purely economic standpoint, if for no more potent reason, the protection of life

and health demands first consideration, and that protective policy is best which best protects the public health and permits the maximum utilization of the other valuable properties of the stream. The safeguarding of a public water supply, however, may be accomplished in one of several ways, and it will serve to exemplify the principle if this case be considered somewhat fully.

Safeguarding Public Water Supplies

Under certain circumstances the entire population may be removed from the tributary drainage area. This is quite feasible and economical when the interests of a large city come into conflict with those of a very sparsely settled country region, and has been done in a few instances. At the other extreme, the water course may be given over to waste disposal and abandoned entirely as a source of domestic water supply. With proper restrictions as to limits of permissible pollution under these conditions, this procedure is often a proper and economic one.

Streams Used for Water Supply and Waste Disposal

More frequently, however, an intermediate condition of affairs prevails, namely, one in which the stream must be used for both purposes. These cases call for the most careful treatment, each one upon its merits. If there be no alternative source of water supply, then stream pollution must be much more severely limited than if readily accessible alternative supplies exist. The possibilities, limitations and cost of water purification and of the treatment of sewage and industrial wastes, must all be considered in the final solution. If, for example, sewage and waste disposal were very cheap and efficient, and water purification expensive and uncertain, a very different result would be obtained upon balancing the economic possibilities of the situation than would follow were the reverse the case.

Relative Distribution of Costs

Again, the relative distribution of the costs, involving the respective sizes of the populations and the values of the industries affected, must also be taken into account. Small communities and industries have, in the past, been completely wiped out in order to make room for the development of a city water supply; and it has frequently been suggested that cities faced with heavy responsibilities for the protection of downstream water supplies could better afford to install new water supplies at their own expense than to enter upon the expensive system of sewage treatment that the situation might otherwise demand.

In this case the larger community assumes the entire financial responsibility for a benefit which it alone enjoys, the smaller community being deprived of its use of the stream. In general, however, the situation is complicated by more nearly equal populations in the two communities and a necessary joint use of the stream. The principle of maximum beneficial use still holds, but the distribution of the responsibility is not so simple.

In order to simplify the matter somewhat, let it be assumed for the moment that the two communities are consolidated so that the financial burden is equitably distributed. Then the proper engineering solution could readily be arrived at. There is a determinable balance between the costs and limitations of water treatment and of waste disposal which could be worked out for the joint community and which would most economically meet the situation. This, then, is the solution of the problem if the distribution of responsibility be eliminated. It is the best possible arrangement that can be arrived at from the point of view of the whole population and of the maximum beneficial use of a natural resource. Is it not then the equitable solution as between two communities that each is entitled under the law to such a reasonable use of the waters as will not restrict a similar reasonable use on the part of the other? To test this question it may be well to apply the principle to a few actual cases.

Pollution of Boundary Waters

The international Joint Commission has before it the question of the pollution of boundary waters between the United States and Canada. Under the waterways treaty of January 11, 1909, these waters may not be polluted by either side to the injury of health or property upon the other. In other words, this treaty applies the common-law principle of riparian rights to the broad international situation.

A board of eminent engineers from both countries, called together by the commission to advise in the matter of remedial measures, recommended:

"In waterways where some pollution is inevitable and where the ratio of the volume of water to the volume of sewage is so large that no local nuisance can result, it is our judgment that the method of sewage disposal by dilution represents a natural resource and that the utilization of this resource is justifiable for economic reasons, provided that an unreasonable burden or responsibility is not placed upon any water-purification plant and that no menace to the public health is occasioned thereby."

Adjustments Between Water Purification and Sewage Treatment

In the case of those situations in which the degree of pollution does place an undue burden and responsibility upon water-purification plants, the writer later recommended purification treatment of the sewage, only to such a point as would permit the treatment of the polluted water by water-purification plants with a reasonable margin of safety. This recommendation was made, however, only after a thorough study of the possibility of sewage treatment had shown that the requirements finally adopted were reasonable and feasible and that additional requirements would have been excessively expensive in view of the minor benefits that would be conferred upon riparian water users below.

This is the adjustment that would likewise have been made were there but one party interested. It represents the economic balance suggested by the engineer, and appears to be the only possible satisfactory adjustment among the various interests, each of whom is permitted thereby to deprive the other of a certain portion of his rights to the use of the waters. The sum total of such deprivation, however, is made less under this arrangement than under any other, so that it complies with the condition of maximum beneficial use.

Pittsburgh Sewage Disposal Problem

A second example may be cited from the history of the Pittsburgh sewage disposal problem. In 1910, Hazen & Whipple made an extensive investigation into the whole question of the feasibility, desirability and cost of collecting and treating the sewage of the Pittsburgh district for the purpose of protecting the water supplies of Ohio river communities. The estimated total cost of the project, including the capitalized cost of operation, was about $46,000,000. Hazen & Whipple, in summarizing their report, state:

"The advantages of carrying out this scheme have been considered with reference to water supply conditions in the Ohio valley and in regard to other matters. It is believed that all the water supplies in the Ohio valley in the State of Pennsylvania probably represent an investment of not more than $2,000,000 or $3,000,000, and a sum much smaller than this would suffice to provide a supply of water of unquestioned purity for all of these works.

"Carrying out the complete scheme of sewage purification would not serve to improve in any important degree the existing water supply conditions in this district or in the Ohio river below the state line.

"It is clear that the advantages to be gained will not justify

the expense of purifying the sewage, and it cannot be recommended."

Plainly the inference is that the maximum beneficial use of the stream is the desirable condition, regardless of the fact that this condition actually deprives a lower riparian community of certain of its rights. While no suggestion of recompense is made, it is clear that the equities are not satisfied until the city has purchased the rights which are thus infringed. This, however, does not affect in any way the fundamental engineering problem.

Concerning the rights of the lower communities, Mr. N. S. Sprague, superintendent, Bureau of Construction, says in forwarding Hazen & Whipple's report:

"As a business proposition it would be many times cheaper for the city, provided the laws would permit, for the city to build the necessary water filtration works for these supplies or possibly supply them with water from the plant at Aspinwall, or, if this is impracticable, to build a new central plant below the city adequate to supply the needs of this population."

Although this statement does not deal with the city's responsibility for damage done to water supplies, it does suggest the financial advantage of paying for that damage and purchasing the right to continue it rather than correcting the condition. It also suggests the practical difficulties that lie in the way of any such equitable and desirable settlements. These are, first, the stream pollution laws of the state, and, second, the lack of legislative provision, by which such arrangement might be legally and easily entered into.

Divided Jurisdiction

The entire situation is further complicated by the fact that most of the great rivers of the country are interstate, in that they flow from one state to another or constitute state boundaries. This fact brings to the problem the added confusion of diverse state laws and divided jurisdiction. Within the boundaries of a single state metropolitan sanitary districts offer a possible, although somewhat difficult, solution. Upon the interstate streams, however, even less can be done. Massachusetts specifically exempts from its stream pollution laws its two greatest streams, which are year by year becoming more and more fouled and concerning which the public sense of decency is becoming progressively duller and less exacting. Ohio and other states, which have attacked the intrastate problem in a progressive manner, have openly or tacitly made similar exceptions.

The Drainage Area Unit

Obviously the minimum legislative and administrative unit for the satisfactory control of stream pollution is the drainage area of the stream. This provides a single jurisdiction and uniform control over the entire stream. The plan of "rivers boards," made up of representatives from each county through which a principal river or its tributaries flow, has been tried out in England, where a great deal of study has been given to the problem of waterways protection. The plan has worked out satisfactorily, although the Royal Sewerage Commission has pointed out the disadvantage of diverse measures of control among the various rivers boards, especially as it affects competing industrial establishments. A central governmental authority has been recommended in addition to the rivers boards.

For Federal Control of Stream Pollution

In this country federal control over the pollution of the interstate streams is very definitely indicated as the only feasible plan of securing a uniform policy and unified watershed jurisdiction. As stream pollution is but one phase of the broader matter of waterways development and control, concerning which the federal policy is at present well advanced and rapidly progressing, it seems fitting and logical that the control of stream pollution in interstate waters should ultimately lodge in the hands of a waterways commission or such other body as may hereafter be constituted to maintain and develop the waterways of the nation.

With the problem in such hands, the principle of maximum beneficial use could be applied without confusion and without injustice. All the equities could be preserved and the costs appropriately distributed. It would then be possible to substitute a scientific and economic development and use of stream resources for the present unsatisfactory and wasteful misuse.

This program leads to unification, wholesome restrictions based upon the principle of maximum beneficial use, and an equitable distribution of benefits and responsibility; the other, to further diversification, increasing argument for the repeal of existing restrictions because of their obvious futility, and continued spoilation of a natural resource, the property of the whole people, for the benefit of a favored few.

This problem is one of national importance; it deals with resources which cannot be wasted or destroyed without affecting the wealth of the nation as a whole; its solution will be found only in federal control.

DRAINAGE AND IRRIGATION

Using Los Angeles Aqueduct Water for Irrigation Purposes

By C. W. Geiger, 721 S. Hope St., Los Angeles, Calif.

City water that formerly went to waste in the Santa Clara River, is now being sold to the beet growers in San Fernando Valley at reduced rates. Because of the extreme dryness of this part of the state, beet growers petitioned the water commission of Los Angeles for adequate water for irrigating the beet fields. After a thorough investigation of the conditions by the water commission, the request of the beet growers was granted. In doing this, the commission could not be charged with discrimination, because the United States Food Administration had asked that every assistance be given the beet growers to enable them to put in their crops, so that any possible sugar shortage next season would be relieved.

The water has been going to waste down the Santa Clara River; and is not required by orchardists for irrigation purposes at this season, so the commission decided that it would be better to obtain this revenue, even at a reduced rate, than to permit the waste to continue. Many thousand ranchers would also be in desperate straits at the present time, April 25, if it were not for the adequate water, that is taking the place of the delayed rains.

San Fernando Valley First Irrigated in 1917

During 1917, the Los Angeles department of public service and the Los Angeles aqueduct were the instruments by which a small inland empire was added to the city's resources. The San Fernando Valley, containing more than 100,000 acres of irrigable fertile land, in 1917 for the first time received the full flow of the aqueduct. The valley three years ago, with its great uncultivated areas, formed a wide contrast with the fertility of the region under irrigation at the present time.

In 1914, within the area now served by aqueduct mains, the

total irrigated area was approximately 3,000 acres. In 1917, this area had been increased to more than 30,000 acres and during 1918 it is estimated that an additional 30,000 acres will come under irrigation. The crops produced in 1917 were estimated at more than ten times the value of those produced in the same district three years before.

During the height of the irrigation season the consumption of water at times equaled the full flow of the aqueduct, or nearly 260,000,000 gals. every 24 hours.

Two Impounding Reservoirs

In 1914, one year after the aqueduct was completed, the quantity of water required for domestic purposes was being delivered into the city's mains. The large surplus designed to be used in irrigation until such time as the city's domestic needs called for its more important use, was valueless for the reason that no means had been provided for distributing it. To this end, two irrigation districts were formed and bonds to the amount of $2,996,000 were voted and sold. As soon as the money was available, the department of public service at once began construction along the engineering plans that had already been prepared. These called for the building of two great impounding reservoirs as a part of the city storage system, 13 miles of concrete supply conduits and nearly 300 miles of great steel trunk lines and smaller laterals ramifying the valley from one end to the other. These smaller lines bring the water, under high pressure, to within a quarter mile of every piece of land in the valley. Cross mains at very low cost put the water in front of every man's door.

Conduit Construction and Pipe Laying

The work of conduit construction and pipe laying was accomplished in the short space of 18 months. An army of 800 men was at work during the greater part of 1917, and its activities were accelerated by the most modern of electrical and gasoline motor equipment. Over 25,000 tons of steel and 55,000 barrels of cement have gone into the engineering structures installed. The camp at Raymer, near the town of Van Nuys, with its durable portable houses, office buildings, warehouses, machine shops and stores, in its heyday had a population of 500 workers and served as the general headquarters for the engineering organization. As fast as pipe lines were laid, taps were made, the land was flooded, then plowed and the crops planted.

As a result of water in adequate quantity now available throughout the valley thousands of acres of lemon and orange groves are being planted along all the foothill slopes and there is in the making now a region as productive as the San Gabriel valley.

CONSTRUCTION VIEWS ON LOS ANGELES AQUEDUCT IRRIGATION DEVELOPMENT.

Left to Right: Dinky Engine and Dump Cars Used in Construction of Chatsworth Reservoir; Earth Transported in Cars and Dumped into Sump—Excavated Material Dumped into Sump and Washed into Place by Hydraulic Jets—Steam Shovel Excavating for Chatsworth Reservoir—View of High Flume on Chatsworth High Line Crossing a "Wash."

Reservoirs Under Construction

Adequate quantity of irrigation water is guaranteed at all times by the San Fernando reservoir, 2½ miles southwest of the town of San Fernando, which has been brought to a stage of completion where it provides storage for 3,747,000,000 gals. of water. As an additional safeguard the public service department acquired 1,300 acres in the vicinity of Chatsworth Park and in October, 1917, began the construction of a reservoir exceeding in capacity the San Fernando. Over 200 men are now employed and this number is being increased as rapidly as additional living accomodations are provided. It is the desire of the chief engineer, to complete the work so far as partially to fill the reservoir for use during this summer.

When weather conditions permit, work will be carried on day and night. On two of the five dams and dykes that are being

built, the core walls have been excavated, and for the largest of these a steam railroad has been built in the reservoir site. The cars are loaded by steam shovels, and the material carried to the top of the dam, where it is sluiced into position in the dam by pumping machinery. It is estimated that by this means 3,000 cu. yds. of material per 16-hour day can be placed in the dam. For the conduit that is to supply the reservoir, all rights of way have been obtained and a camp to house 150 men has been built near Chatsworth. There is approximately 15,000 ft. of concrete lined and covered conduit to be built, and the excavating machines are already at work. The engineers' estimated rate of speed is 300 ft. of completed ditch per day.

Artesian Wells to Supplement Stream Flow

A number of artesian wells are to be sunk in Owen's valley, to supplement the flow of the Owen's river, in case the drought conditions in the valley and the mountains tributary to it continue. There is a tremendous artesian water supply under the land owned by the city in the valley. In case rain or snow does not fall in sufficient quantities, the flow of the river may fall off, and it is to protect the city next year or the year after, in case the dry spell continues, that these wells will be sunk.

The water capacity of the Chatsworth reservoir is 8,958,000,000 gals., enough water for Los Angeles' use for 75 days, were all the other sources shut off. This reservoir will be an auxiliary to San Fernando reservoir, completing a chain of 19 basins to store and handle the flow of the aqueduct water.

The earth is taken out with steam shovels. A permanent camp has been established for employes and will be maintained until the reservoir is completed. It is considered of special importance in completing the efficiency of the San Fernando valley system, as well as providing additional storage for waters needed to operate the power plant. While the two San Fernando reservoirs will be capable of meeting the normal demands of agriculturalists, the Public Service Commissioners anticipate an abnormal demand during the active development period, and they will be in position to meet such demands through drawing upon this new supply.

The construction plans call for two dams, and four dykes. In the largest dam it will be necessary to move from the bed of the basin to the dam 740,000 cu. yds. of earth, while the second dam will require handling and placing of approximately 43,000 cu. yds. of earth. The dam is being built by the hydraulic fill method. The inner and outer walls of earth are first constructed, leaving between them an immense basin. The earth taken from the bed of the reservoir is dumped into a great sump, where it is mixed with water and then hydraulic pumped into the basin between the two walls, until the entire center is solidly filled with packed earth. The entire work requires handling approximately 1,020,000 cu. yds. of earth, being one of the largest jobs of the kind ever undertaken by the department.

The body of water will be slightly more than two miles long, and about one mile wide. The site is a natural basin, with hills so located that they can be used most advantageously as bulwarks for the ends of the dams, and dykes.

Water was turned into the Chatsworth reservoir on April 15, 1918. It is estimated that it will require over two years to complete the reservoir.

Cedar Rapids Gets Decision Which Enables City to Avert Probable Future Flood Calamity

By L. R. Howson, Principal Assistant Engineer, Alvord & Burdick, Consulting Engineers, Hartford Bldg., Chicago, Ill.

Hon. Milo M. Smith, Judge of the Linn County, Iowa, District Court, on October 9, 1917, handed down a decision in the Cedar Rapids River Front Improvement case which is of great importance in establishing a precedent for disputes involving the encroachments by improvements on river channels. In this case, the City of Cedar Rapids had delegated its powers with regard to river front improvements to a Commission composed of five citizens. This Commission, through its consulting engineer, had outlined a plan by which the original river channel would be greatly reduced in area, and had already built a few blocks of river wall on the west side of the river in conformity with the plan.

In March, 1917, there occurred a flood, which while only moderate when compared to those which have occurred in the past and others which may reasonably be expected to occur at Cedar Rapids in the future, nevertheless demonstrated to Mayor Roth and the other city officials the danger of continuing a program which would still further reduce the carrying capacity of the river channel. The city was powerless, however, to alter the plans proposed by the Commission and its Engineer unless it could demonstrate to the court that their plans were dangerous and contrary to a safe public policy.

History of Case

The City of Cedar Rapids first became interested in its river front problems in 1901, and early in that year engaged Mr. Isham Randolph of Chicago, to report upon the improvement of the Cedar Rapids channel through the city. At that time a double channel extended through the main part of the city, each part being about 400 ft. in width. Mr. Randolph made a report to the city in which he recommended that the west channel be closed and that the entire flow of the river be confined in a single channel 420 ft. in width, between vertical concrete side walls. He advised that a channel with a capacity of 60,000 cu. ft. per second (the equivalent of 9½ cu. ft. per second per square mile of drainage area) would be adequate. The channel which be proposed would have an average velocity of flow of 8.9 ft. per second when carrying 60,000 c. f. s.

At the time of this report there were no gaging stations established on the river and Mr. Randolph, in his report, made no attempt to compute from the high water marks the amount of flow which had occurred in the past. In 1902, a gage was established at Cedar Rapids which has been observed daily to date.

Gage Records

Within the 15 years covered by the gage records there have been four floods in excess of 50,000 cu. ft. per second and two of about 56,000 cu. ft. per second, the last of which occurred in March of this year. In this flood the crest height was within 3 or 4 ft. of the top of the arches of the concrete bridges and within 3 or 4 ft. of the street surfaces in the business section of the city. The largest floods of record may be summarized as follows:

1851	70,000 c. f. s.
1858	67,500 to 75,000 c. f. s.
1884	60,000 c. f. s.
1903	52,450 c. f. s.
1906	50,500 c. f. s.
1912	54,100 c. f. s.
1917	56,000 c. f. s.

The last four are from Government gagings.

Plaintiff's Testimony in Trial in District Court

The trial in the District Court furnished one of the most hotly contested battles ever waged in the Iowa courts, occupying over three weeks, largely of expert engineering testimony.

The plaintiffs, the city of Cedar Rapids, introduced the expert testimony of Mr. John W. Alvord of Chicago, Gen. Wm. H. Bixby of St. Louis, Maj. A. A. Marston of Ames, Iowa, and Mr. L. R. Howson of Chicago, all of which tended to show that:

1. A flood of at least 100,000 c. f. s. might reasonably be expected to occur in the Cedar River at Cedar Rapids.

2. The proposed improvements had a safe capacity of but 60,000 c. f. s., and were, therefore, inadequate.

These conclusions were supported by the following data which are here abstracted and summarized from the testimony:

(a) The average annual flood in the Cedar River is approximately 29,000 cu. ft. per second.

(b) Once in every three or four years a flood in excess of 50,000 cu. ft. per second occurs and more rarely greater floods have occurred and may be expected to recur.

(c) In 1884, a flood estimated at about 60,000 cu. ft. per second occurred, and in 1851 and 1858, according to the testimony of old residents, still greater floods occurred, which have been variously estimated at from 67,500 to 75,000 cu. ft. per second.

(d) At Cedar Rapids, the 15, 30 and 60 year period ratios of the maximum flood in each period to the average annual flood checked very closely the ratios suggested by Mr. Weston E. Fuller in his paper before the American Society of Civil Engineers. As the past history of the Cedar River has so closely followed the average, it is probable that the future will also be reasonably close to the average, in which case the maximum flood on the Cedar River will be nearly 3½ times the annual flood, or about 100,000 cu. ft. per second.

(e) The flood of March, 1906, was caused by a 2¼-in. rainfall on the drainage area in a period of 7 days. This very moderate rainfall did not combine with melting snow to any extent, if at all, in producing the flood of 1906.

(f) A rainfall of not less than 5 ins. in a period of 3 days, might reasonably be expected at Cedar Rapids, and while unusual, would be no more unprecedented for that section of Iowa than was the 10-in. rainfall in Ohio, which produced the 1913 flood. A rate of runoff from the drainage area of ⅝ in. per 24 hours, would give a flow exceeding 100,000 c. f. s. at Cedar Rapids.

(g) Maps were introduced showing five great rainstorms which have occurred in the vicinity of the Cedar River watershed which had precipitations of 8 ins. in 2 days, over areas as large as the Cedar River drainage area above Cedar Rapids, and 4 ins. to 5 ins. in 2 days, over areas half as large as the whole state of Iowa.

(h) The flood of April, 1917, was caused entirely by melting snows. Had a rainfall occurred in connection with the melting snows and only increased the runoff ¼ in. per 24 hours, the flood would have approximated 100,000 cu. ft. per second. It was the contention of the plaintiffs' experts that a combination of but a moderate rainfall and melting snow will produce greater flood flows than have been recorded at Cedar Rapids in the past 15 years.

Defendants Testimony

The defendants, the River Front Improvement Commission, introduced the testimony of Mr. Isham Randolph of Chicago, Prof. S. M. Woodward, Dean Wm. G. Raymond of the Iowa State University, Capt. W. F. Bickel, Mr. M. L. Fox, and Mr. T. L. Warriner of Cedar Rapids, whose testimony was to the effect that:

1. A channel having a safe carrying capacity of 60,000 c. f. s. would be adequate.

2. In view of the past history of the Cedar River, at Cedar Rapids (which, however, referred only to the past 15 years, during which there were gage records available) the maximum flood to be reasonably expected would probably not exceed about 60,000 cu. ft. per second.

3. The ultimate or spilling capacity of the channel proposed was 75,000 c. f. s.

4. The submergence of bridge arches through the city when the channel was full to the spilling capacity would not be dangerous as the flood debris would be collected at bridges further upstream.

5. The plaintiff, the city of Cedar Rapids, had itself largely contributed to the flood hazard by bridge and dam construction.

6. None of the largest recorded storms in Iowa had centered over the Cedar River watershed and that, therefore, their future visitation was not probable.

7. Although no investigation had been made, it would probably be economically impracticable to provide a channel having capacity to care for floods which would occur only at rare intervals, if at all.

8. Prof. S. M. Woodward testified among other matters, that a combination of rainfall and melting snow would not produce greater floods than either rainfall or melting snow alone.

9. Mr. Isham Randolph testified that Mr. Weston E. Fuller's flood ratio study was a "clever guess masked by engineering phraseology" and has no value in a study of expected floods.

The defendants contended from the above testimony that a channel such as the one proposed, having an ultimate or spilling capacity of 75,000 c. f. s. was adequate.

Decision of District Court

Upon the conclusion of the arguments by attorneys, Mr. O. N. Elliott, City Solicitor, and Mr. Lew Dennis for the plaintiffs, and Mr. Jas. Trewin and Mr. John Redmond for the defendants, the Honorable Milo M. Smith decided the case in favor of the plaintiffs, stating that from a clear preponderance of the evidence, the Court decided that:

1. Any further reduction in the Cedar River channel would be dangerous.

2. The channel proposed by the River Front Improvement Commission and its engineer, provided for such a reduction and public welfare demanded its prohibition.

3 The channel proposed was inadequate to carry the flood water volume reasonably to be expected in the Cedar River.

This decision restores to the council of the city of Cedar Rapids, the power to direct its river front improvement policies and insures to the community the safety which can only be secured by providing an adequate channel and brought to a close in the Lower Court, a case which is said by Judge Smith to be "the most important case that has come within my notice during the 60 years that I have been connected with the bar, either as a practitioner or upon the bench."

The writer was in court during the entire trial, and having heard the testimony of all of the experts on both sides, has undertaken to set forth the pertinent facts of the testimony in a complete and impartial resume.

The River Front Improvement Commission were given until April 9, 1918, to appeal, and a few days prior to that date, they appealed and the case is now before the State Supreme Court for final decision.

WATER WORKS MAINTENANCE AND OPERATION

Installing 17,250 Ft. of "National" Matheson Joint Pipe Without One Fitting

A compound curve in a line made up of 17,250 ft. of 24-in. outside diameter "National" Matheson joint pipe installed in Ogden Canyon, Utah, is shown in the accompanying illustration.

Matheson joint pipe is used on lines of this kind because it offers a maximum reliability of service and is easily installed in difficult places. This type of pipe is also employed in city water lines, where certain emergencies often arise which make it desirable to have highly dependable pipe—fire protection lines, for instance, where suddenly increased pressure must be anticipated and provided for.

Physical Characteristics

The tensile strength of the material from which this pipe

COMPOUND CURVE IN LINE OF 24-IN. "NATIONAL" MATHESON JOINT PIPE.

is made averages about 58,000 lbs. per square inch; its elastic limit is in the neighborhood of 34,000 lbs., and it gives an elongation in 8 in. of 20 per cent. Coupled with these physical properties is uniformity of structure, which offers great resistance to corrosion or other forms of disintegration. Corrosive conditions in service are often so severe that ordinary pipe will not last long. It is the nature of the ferrous metals to go into solution and be oxidized (or corroded), and this reaction is accelerated according to the amount of free acids and salts that are in solution, and especially where stray electric currents leave the pipe. Since electrolysis has become an important factor in the durability of pipe underground, the necessity of pipe protection has become more apparent.

"National" Coating

Even without a protective coating, Matheson joint pipe makes a durable installation, but for certain abnormal underground conditions a form of protection is given by "National" coating. This coating is applied in the following manner: The pipe is first cleaned, then dipped in a special bituminous compound, where it remains until the pipe has assumed the same temperature as the bath. It is then removed and allowed to cool, after which it is spirally wrapped with fabric which has been saturated with the hot bituminous compound. The coating thus applied is about 5/64 (.078) of an inch thick, while ordinary paints or bituminous dips rarely exceed 1/100 (.010) of an inch. Arguments have been advanced that because it is necessary to coat pipe, the pipe itself must be weak. As a matter of fact, practically all pipe, which is to be laid in the ground, is given a bituminous coating of some kind.

A great advantage of this pipe is that small variations in alignment and grade are taken care of by the joint itself. By using short lengths of pipe, expensive fittings and pipe bends can be avoided, for the increased number of joints permits considerable deflection in the line. Note the compound curve in the illustration, made in this manner. Not a single fitting was used in the full length of this 17,250-ft. installation.

Economies

To carry a given pressure, "National" Matheson joint pipe weighs less per foot than any other pipe. This reduction in weight is a very important factor, as it lowers transportation expenses, cost of handling and rehandling, and facilitates installation.

In the saving of lead this pipe joint stands above all other joints, not only for the reason that there are fewer joints per mile, due to the comparatively long lengths of the pipe obtainable, but because less lead is required to make each joint. The pipe is in use from British Columbia to Mexico; it has been laid in all sorts of soil—in damp ground, in earth impregnated with alkali, sulphur and arsenic; in many places where other pipe has given out after a few years, this pipe today is in service almost as smooth, inside and out, as when first laid. In fact, it is usually the case that the capacity of a line of this pipe is outgrown by the increased size of a town and has to be taken up to make way for larger pipe. The smaller pipe is then cleaned and redipped or coated and installed in other parts of the line, thus rendering a lifetime of service, for in cases of this kind the pipe is usually found to be as good as new, the coating only having deteriorated after long use.

The Division of Coal Consumed Between Units of Light and Water Plants

By W. G. Kirchoffer, Sanitary and Hydraulic Engineer, Madison, Wis.

At first thought one would hardly expect that it would be possible to fire a steam boiler for the operation of an electric light plant and a water works pump so that by a simple algebraic equation it would be possible to determine what portion of the coal went for the operation of each unit. Such a solution may not be possible in all cases, but here are two illustrations where it is strikingly true.

Fort Atkinson, Wis., Plant Test

At Fort Atkinson, Wis., the municipal light plant was formerly operated by a steam plant in conjunction with a water works plant. Recently a high tension line has been run into the city from the large hydroelectric plants near by so that the steam plant is no longer used for the electric light plant, but only for the water works pumps. In order to reduce the peak load of the lighting plant to a minimum and thus avoid a high demand charge for current, the steam plant is used for lighting during the holiday times, carnivals and such other times that require a large amount of current.

During these times the exact number of hours of operation of the generators are recorded as well as the tons of coal consumed. During three successive months the lighting plant was operated 38½ hours, 11½ hours and 6 hours, in addition to operating the pumps and consuming respectively 102, 82.6 and 77.8 tons of coal each month. If we represent the tons of coal consumed by the lighting plant per hour by Y and that consumed by the pump per month by X, from the above data we have the three following equations:

(1) $38\frac{1}{2}\ Y + X = 102$ tons of coal.
(2) $11\frac{1}{2}\ Y + X = 82.6$ tons of coal.
(3) $6\ Y + X = 77.8$ tons of coal.

Solving for X and Y we have from No. 1, $Y = .756$.
No. 2, $Y = .832$.
No. 3, $Y = .811$.

Taking the average we have $Y = .8$ tons, $X = 73$ tons. By substitution of these values in the equations (1), (2) and (3), and solving for the amount of coal consumed, we find that in the first case the computed value is in error by only 1.76%, the second by .5% and the third by .0%, thus showing the possibility of accurately dividing the coal consumption among different units by accurately recording the hours of operation of each.

Platteville, Wis., Test

At Platteville, Wis., a test was made to determine the amount of coal consumed by an air compressor for an air-lift pump and for the operation of a duplex steam pump. When the air compressor was operated alone 30 lbs. of coal were consumed to raise 1,000 gals. of water 110 ft. into the surface res-

ervoir. When the steam pump was operated alone it required 15 lbs. of coal to raise 1,000 gals. 180 ft. into the elevated water tank. When the two were operated simultaneously it required 33 lbs. per 1,000 gals. from well to elevated tank. From this data it is possible to determine the stand-by losses of the plant. If X represents such losses in pounds of coal, Y represents the pounds of coal per 1,000 gals. to operate the air compressor, and Z that for the steam pump. We would have

$$X + Y = 30 \text{ lbs.}$$
$$X + Z = 15 \text{ lbs.}$$
$$X + Y + Z = 33 \text{ lbs.}$$

A solution of these simple equations divides the coals as follows:

Standby losses	12 lbs. per 1,000 gals.
Air lift	18 lbs. per 1,000 gals.
Steam pump	3 lbs. per 1,000 gals.

These solutions illustrate two things very forcefully: the inefficiency of the air lift as compared with a steam pump and the fact that with a steam plant once in operation, the addition of another unit requires comparatively a small amount of coal to operate it. In fact in a very large plant with the taking on of another very small unit the added coal consumption would scarcely be recognized.

Practical Measures for Securing Greatest Economy in Public Utility Plant Operation

By Charles Brossmann, Consulting Engineer, Indianapolis, Indiana

III—The Boiler and Furnace

This world is ruled by ideas; that is the reason we have progressed. Ideas become knowledge, and there has been a great amount of knowledge stored up, mainly in men's brains, in books, etc.; the only trouble lies in the fact that it is not well distributed. Ideas and knowledge hidden away do no good. They are like coal before its discovery; all there and only waiting to be used to get the good out. The same is true of ideas.

Every man has ideas; some great ideas and some small ones, and with the proper weeding out of bad from good, he is in position to use and derive the benefit from them.

Now, if you are firing a boiler or operating a steam, water or power plant of any description, you have had ideas on your particular work. They may have been but momentary or fleeting; the great trouble with all of us is to hold the right idea and use it.

Large Coal Wastes in Other Lines

Let us start thinking a little more about our coal pile, our boilers, furnaces, stack, etc., and their relation to each other. Let us consider first a few of the large wastes by the other fellow, if you please.

Some one has stated that the skip-stop plan of operating street cars would eliminate so many stops that it would save over a million tons of coal a year. The Bureau of Mines states that last year in the coal mined (which was approximately 600,000,000 tons) there was about 5 per cent more ash than in the coal of the previous year. This meant not only more firing in your plant, but more labor all around, due to trouble in handling poorer coal. Then all this excess ash had to be first hauled in cars to your plant, which called for additional capacity by the railroads, and again the ash had to be hauled away from your plant after the coal was burned. Now this only shows part of the coal waste of the country.

Steps have already been taken to stop some of the above wastes, but suppose some of us try to find out what we are wasting and do our bit at the furnace door.

There are so many places where waste can occur if it is not looked after that it is necessary to dissect our plant and study its component parts, to see if we can improve here or there, a little at a time.

Furnace Efficiency

Usually a boiler and its setting are considered as a unit This is not strictly true. Let us consider these separately. The furnace is the chamber for burning the fuel, a place to liberate the heat from the coal, allowing it to escape from its imprisoned state. That is the main function of the furnace and its grates, stokers or equipment. The transposition of the heat from furnace to the boiler is determined by the boiler, its design and the draft conditions, etc.

But the furnace itself can only be concerned with liberating the heat from the fuel. Furnace efficiency is one thing and boiler efficiency is another. Furnace efficiency depends on a great many things, most of them small in themselves, but all must be watched. Our two aims of importance are to use up *all* the fuel and to see that we transfer as *much* as possible of the heat liberated in the furnace into the boiler. This sounds easy, and there are ways of telling how far you are succeeding in this. Try to lose sight of the fact that you are burning coal to run a pump or an engine, but think that you are manufacturing steam from coal. Try to get the greatest amount of steam from the least amount of coal; that is your object. If you were operating a steam heating plant that is what you would be striving for, and the success of your heating plant in these times of high coal prices would depend largely and mainly on your keeping the cost of steam down. Can you say today what it is costing you to evaporate 1,000 lbs. of water into steam? If you don't know, you should.

There are too many other wastes for you to be unconcerned with yours. Coal is wasted right at the start in mining; then in loading, in transportation and in unloading. It may then be placed in storage at your plant, where there is more waste, perhaps slow, but depending on the coal and how it is stored. All these losses are small, however, compared to what you lose in passing it through the furnace.

Perhaps around 1 per cent is lost in loading and transportation, probably 1 per cent or part of 1 per cent is wasted in unloading and handling up to the furnace, dependent upon how clean you are in your boiler room. This is another one of the little fractions.

You are shoveling coal into the furnace; firing or shoveling. There is a difference. Let us fire our furnace as it should be fired, and as we have discussed it before, keeping out the black spots and firing evenly and alternately, first one side and then the other. Perhaps you are doing as well as possible, as far as looks are concerned. The fire looks right, it seems white hot, and the draft is good and the stack does not smoke excessively. But how do you know that it is right? You can't tell by looking at the fire just what the furnace is doing.

Excess Air

Theoretically we know it takes 11 to 12 lbs. of air to burn 1 lb. of coal, but you cannot expect to meet theoretical conditions. From 50 to 100 per cent excess air is nearer what you will use, even if you exercise care.

Any excess air that you use over what is actually required results simply in the mechanical cooling of the furnace. The carbon has already united with the proper amount of oxygen to form CO_2 (carbonic acid gas) and can take up no more. Any excess air therefore performs no useful function, and merely dilutes the gases and extracts the heat from the furnace and therefore affects its economy.

Carbonic acid gas, commonly called CO_2, is a constant product of combustion and is 1 part carbon and 2 parts of oxygen. Now, of what use is this to us? We are concerned with the practical economy of our furnace and not theoretical figures. True. But you would not attempt to operate your boiler without a steam gage. Not for a minute. You could,

though. Your safety valve would pop off if the pressure were too high, or your pump or engine would slow down and stop if it dropped too low. But this practice would be uneconomical and bad for the boiler, of course. Fluctuating conditions in your furnace are bad; not so much because of their physical effect as for the effect on economy of operation.

The percentage of CO2 is an index of your furnace efficiency. It is an indication of the proportion of used air to unused air, and you know that there cannot but help be a certain proportion of air to coal that will give maximum results or best efficiency. Therefore, when you draw away from this condition you are going to lower efficiency. It is therefore necessary to think in terms of CO2. What percentage should I strive for?

If the best steam economy of your pump were 18 lbs. consumption per horse-power you would endeavor to keep it there by making conditions right. The same should be done with your furnace. Keep the conditions such that you will get the best economy.

Flue Gas Analyses

Now you cannot tell what your flue gases analyze by instinct or sight, but you must have the proper equipment.

For this work you will require some type of flue gas analyzing apparatus. There are several makes and types. The most widely used is the Orsat Hand Apparatus, which consists of a measuring burette, three pipettes for absorbing the gas, and a leveling bottle and header. The pipettes are of glass and U-shaped. One contains caustic potash solution to absorb the CO2, one contains an alkaline solution of pyrogallic acid for the absorption of oxygen, and one contains an ammoniacal solution of cuprous chloride for absorbing carbon monoxide. The apparatus is simple, and with a little practice is easily operated and readily understood.

It is also possible to procure a small pocket CO2 indicator, which is extremely simple, and but little preparation is required for its use. This shows only CO2 readings.

In addition to these hand testing instruments, more elaborate automatic recorders can be purchased. If such an apparatus is purchased it should be simple and fully guaranteed. However, the hand apparatus is essential and there are several good ones on the market.

Full directions for operating are given with these instruments. It is necessary only to fill the pipettes with the proper solutions and then exhaust the gases into them and then read the percentages.

Significance of Percentage of Excess Air

The essential thing to be determined is the percentage of CO2 gas, which will indicate the excess air used. The following table will show approximately the amount of excess air which is indicated by various percentages of CO2.

CO2.	Per Cent Excess Air.
2	935 Bad.
4	417
6	245
8	158
10	108
12	73
14	48
15	38 Good.

The actual percentage of fuel loss due to excess air is about 1 per cent for each 12 per cent excess air over the 38 per cent excess air, or 15 per cent CO2.

For example: If your gas analyzed 15 per cent CO2, this shows only 38 per cent excess air (which, of course, is very good). Now, if your analysis showed 6 per cent CO2, or 245 per cent excess air, the percentage of fuel loss would be 245—38=215÷12=about 18 per cent fuel loss due to excess air.

This shows that you are heating all this excess air for no purpose and wasting about 18 per cent of your fuel—firing harder, working harder, making it harder for some other fellow to get coal, and making the railroad haul you almost 18 per cent more coal than you really need.

Checking Excess Air

It is, of course, one thing to know you have a loss or a leak and another to find it, and this is your problem. The first thing is to hunt for air leaks in and around the settings; these can easily be found with a little determination and a candle. Stop them all up. This was gone into more fully in the previous installment of this series of articles; see the April issue. Then take another reading and see if conditions are bettered. Then go after the fire; see if there are holes in the fire bed and if the coal is evenly spread. Now get your draft gage, for I assume you have one; if not, you should have, as they can be purchased for $5 or $10. Then take your furnace draft readings and uptake draft readings at the same time you analyze for CO2. Your draft may be too great for the thickness of fire that you carry.

Draft Conditions

From now on you will have to determine what the relation of draft, fire thickness and CO2 bear to each other. Your draft cannot be cut down so low that you do not get the proper amount of steam. While you might run up the CO2 to 15, or even above, it might be that your steam would drop. Your first business is to make steam, and then make it as economically as possible.

Find your best draft condition with the best CO2 reading and determine your best fire thickness. All these factors must bear their proper relation to each other. It is necessary that you do things quickly in performing the analyses, as conditions in your furnaces change every few minutes, especially so in a hand-fired plant.

After you find what is best for your plant have your fireman try to keep these conditions obtaining. Regulate your draft with the damper and not with the ashpit doors. Keep the fire at the proper level—that level you have found best. Have the fireman use some kind of guide for his fire thickness, as far as possible. Judgment and head work are essential to getting results, and you will have to work out your best methods.

If by analyzing at different points, at the furnace and different passes of the boiler, you have determined to your satisfaction that the air leakage is stopped as far as practicable, and that on two samples taken, one at the first pass and one at the last pass of your boiler, it shows about the same percentage of CO2 for almost simultaneous reading. Then you can feel that you are getting things in good shape.

Keep on with your CO2 investigations, and become familiar with the apparatus. An intelligent fireman can learn to use it, an operating engineer certainly can, and without much trouble, and it is not necessary to be theoretical about it. You can read it as readily as your steam gage; don't quit because it is some trouble. You will never save coal without trouble. Stick to your little glass analyzer and get your CO2 up to 12, 14 or 15 per cent if you can.

Not Enough Air

Low CO2 readings are almost always an indication of excess air, but sometimes not. It is well to know what the percentage of CO (carbon monoxide) is, as this is usually an indication of improper combustion. It is not necessary to bother about this reading until we have gotten our CO2 up somewhere near the point we want it. CO is usually an indication of not enough air, and there has not been enough or it has been improperly distributed and the carbon has not combined with the oxygen in proper proportion.

It is not necessary to take CO readings every CO2 reading, although some do it. As CO2 is almost always caused by excess air, we will usually be safe in first bringing up our CO2 readings and getting out conditions right and then trying

for CO. If we find only a trace, we can be satisfied that things are looking good. If CO shows it may be necessary to carry a little more draft or thinner fires to eliminate the (carbon monoxide) CO by giving more air to the furnace.

Summary

To summarize what is most important: Carry your load with a draft that will give you the highest CO_2 readings and see that this is without CO. This must be determined by the cut-and-try method until you find your best condition. Keep your fires uniform in thickness. Regulate draft from your uptake damper. Be sure and have a draft gage where the fireman can see it. Find out your very best conditions and set this mark and operate to it. If your natural furnace condition and boiler setting are bad, that is another thing. Do what you can to correct small defects, such as air leakage, etc., and when you reset your boilers find out what changes will help you. But this need not stop you from doing your best under the prevailing conditions. Make sure what is the best that can be accomplished and make your boiler room force stick to this.

Don't forget your boiler room record. Start this at once and get your firemen to take an interest in it. Don't forget that public service commissions are starting to inquire more deeply into the manner of operating plants when rate increases are asked for. If you are spending ten, twenty or thirty thousand dollars or more a year on coal, be sure you know how the coal is spent. You know how much you paid for the coal. If you bought the worst coal in the market, you would hear about it. What are you getting for your coal?

How the Contractors are Bidding

Bids Received for Water Works Improvements at Twin Falls, Idaho

Bids were received for water works improvements at Twin Falls, Idaho, on April 18, 1918. Bids were received on seven contracts.

The water works improvements on which the bids were received were designed by Burns & McDonnell, consulting engineers, Interstate Building, Kansas City, Mo.

Contract No. 1—General Construction

Contract No. 1 covered general construction, and was awarded to the Heuser-Packard Company, 310 Atlas Building, St. Louis, Mo., at $72,700. The time of completion under this contract is scheduled as November 1, 1918. The unit bids of the successful bidder on this contract were as follows:

Earth excavation, 50c per cu. yd.; rock excavation, $3 per cu. yd.; earth fill of reservoir embankment, 50c per cu. yd.; reinforcing steel and structural steel, each at 7c per lb.; concrete, $20 per yd.; 4-in. machine banded wood pipe furnished and laid at 50c per ft. and 6-in. pipe of same type furnished and laid at 60c per ft.; 24-in. pipe of same type hauled and laid at 25c per ft.; 4-in. drain tile furnished and laid at 15c per ft.; 6-in. at 20c; 8-in. at 25c; 10-in. sewer tile furnished and laid at $1.30 per ft.; 12-in. at $1.45; 18-in. at $3; 24-in. at $4 per ft.; 33,000 ft. board measure lumber in mixing chamber at $50 per thousand.

Contract No. 2—Trenching and Pipe Laying

Contract No. 2 was for trenching and pipe laying, and was awarded to William Harkins of Twin Falls, Idaho, at a total of $42,911.95. The time of completion under this contract was four months. The unit prices of this successful bidder were as follows:

4-in. cast iron pipe in 12-ft. lengths, with cast lead joints, 43c per ft.; 6-in. pipe, 43c; 8-in., 45c; 10-in., 48c; 16-in., 65c; 20-in., 70c.

4-in. cast iron pipe in 16-ft. lengths, with cast lead joints, 38c per ft.; 6-in., 40c; 8-in., 45c; 10-in., 45c.

4-in. cast iron pipe in 12-ft. lengths, with metallium joints, 40c per ft.; 6-in., 40c; 8-in., 42c; 10-in., 45c; 16-in., 60c; 20-in., 70c.

4-in. cast iron pipe in 16-ft. lengths, with metallium joints, at 36c; 6 and 8-in. at 40c; 10-in., 45c.

4-in. Matheson joint "National" pipe, 37c per ft.; 6-in., 37c; 8-in., 40c; 10-in., 45c; 16-in., 55c; 20-in., 65c.

4-in. Universal cast iron pipe at 31c per ft.; 6-in., 31c; 8-in., 32c; 10-in., 36c; 16-in., 40c; 20-in., 50c.

4-in. machine banded wood stave pipe, 27c per ft.; 6, 8 and 10-in. at 27c per ft. also; 20-in., 40c; 24-in., 60c. Trenching and backfilling 24-in. continuous wood stave, 50c per ft. Hauling and setting new fire hydrants, $10 each, and same for old fire hydrants. Resetting old fire hydrants only, $10 each. 3-in. gate valves hauled and set, $5; 4, 6 and 8-in. gate valves hauled and set, each, at $5; 10-in., $10; 20 and 24-in., $10 each. Furnishing material and labor to build manhole for 20-in. valve, $50. Furnishing material and labor to build manholes for air valve, $40 each. Rock excavation in trenching at $3 per cu. yd. Cutting and replacing pavement at $2 per sq. yd. Furnishing material and labor to place concrete at $18 per cu. yd.

Contract No. 3—Filters

Contract No. 3 for the water filters was awarded to the Pittsburgh Filter Company of Pittsburgh, Pa. The bid on a 4,000,000-gal. plant was $47,700 and on a 6,000,000-gal. plant was $61,700.

Contract No. 4—Cast Iron Pipe

Contract No. 4, for cast iron pipe, was awarded to the American Cast Iron Pipe Company, of Chicago, and was for Hitensile pipe, at a total of $54,371.72.

The bids of this successful bidder were as follows: 34.3 tons of 4-in. Class "B" bell and spigot pipe in 12-ft. lengths, $71 per ton; 916.4 tons of 6 to 20-in. Class "B" bell and spigot pipe in 12-ft. lengths at $68 per ton, and 50,000 lbs. of cast iron specials at 5¼c per lb. All bids were $1 per ton higher for 16-ft. lengths than for 12-ft. lengths.

Contract No. 6—Wood Stave Pipe

Contract No. 6 was for furnishing wood stave pipe, and was awarded to the Redwood Manufacturing Company of San Francisco, Cal., at a total price of $57,874.95. The successful bidder agreed to begin work within 20 days after the contract was awarded and to finish the work in 60 days.

The unit prices of the successful bidder were as follows:

24 in. Continuous Stave Pipe Price per Ft.	Pressure Head in Feet	24 in. Machine Banded Pipe
$1.75	0 to 40	$2.07
1.82	40 to 50	2.07
1.91	50 to 60	2.34
1.99	60 to 70	2.34
2.10	70 to 80	2.52
2.21	80 to 90	2.52
2.32	90 to 100	2.52
2.43	100 to 110	2.80
2.54	110 to 120	2.80
2.65	120 to 130	3.09
2.76	130 to 140	3.09
2.87	140 to 150	3.09
2.98	150 to 160	3.22
3.09	160 to 170	3.22

3.20	170 to 180	3.58
3.32	180 to 190	3.58
3.44	190 to 200	3.58

20-in. machine banded pipe for 200-ft. head, at $2.49 per ft.; 10-in. same head, 93c; 8-in., 73c; 6-in., 51c; 4-in., 35½c. For furnishing and installing ½-in. air valves and castings on 24-in. pipe, $45 each; furnishing cast iron fittings, 8c per lb.

Contract No. 7—Hydrants and Valves

Contract No. 7 was for furnishing hydrants and valves and was awarded to the Rensselaer Valve Company, of Troy, N. Y. Fire hydrants, with steamer connection, at $59.75 each; 3-in. gate valves, with screw ends, at $11.15 each; 4-in. hub end gate valves for wood pipe, at $11.15 each; 6-in., at $19.75; 8-in., at $29.60; 10-in., at $43.30; 4-in., at $11.15, for cast iron pipe; 6-in., $19.75; 8-in., $29.60; 10-in., $43.30; 20-in. hub end geared with by-pass, $268; 24-in. geared with by-pass, for wood pipe, $370; 24-in. gate valve without by-pass, for wood pipe, $272; 16-in., $131; two-piece valve boxes, $7.40 each.

The total bid for hydrants and valves was $11,074.95. Time of delivery, 35 days.

The Evils of Unbalanced Bids on Municipal and County Contracts

By a Prominent Contractor

In these times of highly efficient engineering training and practice it should not be either necessary or interesting to call attention to the iniquities of the matter of contractors making unbalanced bids nor to the practice of engineers in making specifications and estimates in such a way that it is possible for the contractor to practice the iniquity.

It has been well said that unbalanced bids necessarily begin with the engineer who made the estimate and specifications. This does not say that the engineer is *per se* dishonest, but it does say that he has at least not practiced possible care. If the estimated quantities on which the engineer asks for bids are carefully prepared to give the relative quantities of different items of the work as accurately as possible, and if the specifications are carefully drawn to fit the estimated quantities, then there will be no incentive to unbalance bids, and, however inherently dishonest the contractor may be, he will not try to practice dishonesty in that way and there will be no unbalanced bids.

Some Specific Examples

By way of illustration let me give a few glaring instances which have come to the writer's attention in his practice as a contractor.

Deepening the Erie Canal

1. In the year 1899 the state of New York appropriated $9,000,000 for deepening the Erie canal from 7 ft. to 9 ft., its entire length from Albany to Buffalo. The work in general and primarily consisted of excavating 1 ft. from the bottom of the canal and raising the towpath 1 ft. and the attendant raising and lowering of slope and vertical walls, etc.

The contracts were generally let in sections of from 3 to 7 miles, more or less. Two items of the contract were:

"*Excavation*"—Defined as usual as material removed from the canal and paid for per cubic yard, measured in the cut.

"*Embankment*" in the specifications was described as: (a) Earth hauled from outside the work and deposited within the lines of the canal, regardless of length of haul. (b) Overhaul on earth excavated from the canal and hauled more than 1,000 ft. and deposited either within or outside of the canal limits.

Both classes of "embankment" were covered by one bid item per cubic yard, and only one quantity given in the estimate on which bids were canvassed. Most of the contracts were through the country districts and the material excavated from the bottom of the canal used to raise the berme side, the towpath side to be raised with "gravel" and paid for as a separate item. Consequently in such cases there would be but little of either (a) or (b) class of embankment, and consequently a nominal quantity (generally 1,000 cu. yds.) of "embankment" was provided in the estimated quantities on which bids were canvassed. Through the cities, however, generally for distances of 2 to 4 miles, all the excavated material had to be hauled much farther than 1,000 ft., and here is where some "wise" contractors got in their fine work of unbalanced bids.

In one case with which the writer had occasion to be especially familiar the matter figured out as follows, the quantities being from memory of nearly 20 years, but sufficiently accurate to illustrate the point now under consideration.

The estimated quantities were approximately:

90,000 cu. yds. "excavation."
1,000 cu. yds. (nominal) "embankment."

The bids of the lowest two bidders as to these two items were about:

	(a) Canvassed low	(b) Canvassed high
Excavation, 90,000 cu. yds.	@ 30c $27,000	@ 35c $31,500
Embankment, 1,000 cu. yds.	@ 60c 600	@ 25c 250
Totals as paid for	$63,000	$46,500

But—the final quantities paid for ran about:

		If this bid had been accepted cost would have been
Excavation, 90,000 cu. yds.	@ 30c $27,000	@ 35c $31,500
Embankment, 60,000 cu. yds.	@ 60c 36,000	@ 25c 15,000
Totals as paid for	$63,000	$46,000

The State lost $16,500 through acceptance of the "low" unbalanced bid, made possible through lack of foresight of the engineer in making his cost estimate.

A Brick Paving Job

2. Bids were separately received per square yard for brick pavement within and asphalt pavement outside of the rail area. Through clerical error the engineer divided the square foot area within the track area by 27 instead of by 9, to reduce to square yard area. Consequently the estimate on which bids were canvassed was only one-third the actual area. One contractor bid abnormally low for the asphalt pavement correctly estimated and correspondingly high for the brick pavement eroneously estimated.

3. It is believed that the following editorial from Municipal Engineering, September, 1910, regarding an experience of the city of Chicago, is worth reprinting here in full.

Loss in Chicago Paving Contracts

The Merriam Commission reported to the Chicago city council on August 5 regarding the operations of Contractor McGovern, whereby he received excessive compensation from the city in certain paving contracts made in 1908 and 1909. McGovern, it will be remembered, is the contractor indicted for the "shale rock" fraud on the Chicago sewer work, and cleared when the case came to trial.

In its report on the paving contracts which the city gave to McGovern in 1908 and 1909 *the Merriam Commission deals with the 1-cent bid made by McGovern, and declares he was paid $413,247.64 for work which should have been done for $266,064.54.*

The acceptance of this unbalanced bid, and the extension of the contract to about eight times the quantity of work named in the original schedule resulted in the loss to the city of a large sum of money. The contractor was paid $413,247, while, if the proposal of the Western Construction and Maintenance Company, which was the next lowest to the McGovern bid, had been accepted, the amount paid for the same work would have been only $266,064. In other words, the city would have saved $147,183 on the contract.

Comparison of cost of the work done under the McGovern contract with what it would have been at the prices of other bidders shows:

Item	Amount	Contract Prices Unit	Contract Prices Total	Other Bidders Unit	Other Bidders Total
Repairs, class A, sq. yds.	229,891	$1.75	$402,309.25	$1.04	$239,006.64
Repairs, class B, sq. yds.	12,064	.01	120.64	1.40	16,889.60
Cement concrete, cu yds.	643	3.25	2,089.75	5.00	3,215.00
Binder delivered, tons..	2,182	4.00	8,728.00	3.15	6,873.30
Total			$413,247.64		$266,064.54

The report, in explaining the 1-cent bid, points out that work referred to as "Class A" consisted of resurfacing, while work referred to as "Class B" consisted of putting in concrete and binder as well as resurfacing. *McGovern bid $1.75 a square yard on the ordinary resurfacing work and bid 1 cent a square yard for putting in concrete and binder and doing the resurfacing.*

Asphalt Pavement Repairs in Boston

Coming down to a very recent date, March, 1918, the city of Boston received bids for asphalt pavement repairs. The bids received were as given in Table I:

TABLE I—REPORT OF BIDS RECEIVED ON ASPHALT PAVEMENT REPAIRS IN BOSTON, MARCH 18, 1918.

Items —Quantities as Estimated for the Purpose of Canvassing Bids March, 1918—	Units	As Estimated for 1918	Contractor No. 1 Bidder Rate	Contractor No. 1 Bidder Total	Contractor No. 2 Rate	Contractor No. 2 Total	Warren Bros. Co. Rate	Warren Bros. Co. Total	Rowe Contr. Co. Rate	Rowe Contr. Co. Total
Asphalt surface, 3-in. depth, sq. yds.		35,000	$ 1.55	$54,250.00	$ 1.38	$48,300.00	$ 1.49	$52,150.00	$ 1.75	$61,250.00
Asphalt surface, 1-in. depth, sq. yds.		10,000	.01	100.00	.60	6,000.00	.69	6,900.00	.50	5,000.00
Extra binder, cu. yds		50	11.00	550.00	12.00	600.00	12.91	645.50	12.00	600.00
Extra concrete, sq. yds		200	3.00	600.00	3.50	700.00	2.27	454.00	2.80	560.00
Total				$55,500.00		$55,600.00		$60,149.50		$67,410.00
—If canvass based on quantities actually paid for in the year 1917—										
Asphalt surface, 3-in. depth, sq. yds.		45,224	$ 1.55	$69,987.20	$ 1.38	$62,409.12	$ 1.49	$67,383.76	$ 1.75	$79,142.00
Asphalt surface, 1-in. depth, sq. yds.		240	.01	2.40	.60	144.00	.69	165.60	.50	120.00
Extra binder, cu. yds		242	11.00	2,662.00	12.00	2,904.00	12.91	3,124.22	12.00	2,904.00
Extra concrete, sq. yds		2,407	3.00	7,221.00	3.50	8,424.50	2.27	5,463.89	2.80	6,739.60
Total				$79,872.60		$73,881.62		$76,137.47		$88,905.60

"Contractor No. 1" and "Contractor No. 2" are so closely related that the relation could not be seriously denied. The unbalanced features of both bids are most glaring in the following particulars:

(a) Bid for asphalt surface 1-in. depth, only 1c per square yard, and 155 times as much for only double the depth of surface.

(b) The aggregate of both bids on all items of the two bidders, omitting the nominal item of concrete, totaled on the estimated quantities *exactly the same—$49,900.*

(c) On the item of concrete one contractor bid exactly $100 higher than the other, making the glaringly unbalanced bid canvass $100 low.

This collusion gave one bidder two chances at the contract at practically the same price as canvassed, but at vastly higher actual cost to the city if the "low" unbalanced bid had been accepted.

The bidding blank supplied by the city and signed by all contractors contained the following:

BOSTON ASPHALT REPAIR BIDS

Extract from printed matter in Proposals of all Bidders

"The undersigned declares that the only persons interested in this bid as principals are named herein as such; that no official of the city and no person acting for or employed by the city is directly or indirectly interested in this bid, or in any contract which may be made under it, or in any expected profits to arise therefrom; that this bid is made in good faith, without fraud, collusion or connection with any other person bidding for the same work."

Under the clear agreement of the bid and under the best practice in letting contracts, the two apparently collusive bids would have been rejected, but after very careful consideration the mayor decided to award the contract to "Contractor No. 2," whose prices were not clearly unreasonable on any item. In taking this action the mayor reasonably explained that it was necessary to begin the work of repairs without waiting to readvertise, which he felt would be necessary if neither bid was accepted.

The following article is quoted from the *Boston Transcript* of March 22, 1918:

SCORES COLLUSIVE BIDDING

Massachusetts Highway Association Passes Resolutions Against Practice All Too Common in American Cities

At a well-attended meeting of the Massachusetts Highway Association, held last evening at the New American House, motion pictures of road construction and road machinery were shown, followed by an "experience meeting" on the subject of road repairs. After very full discussion, the following resolutions were passed with but one dissenting vote:

Resolved, That in the opinion of this association, when in competitive bids any item is offered at manifestly less than its actual cost, such bid should be rejected as "unbalanced," unfair and against the interest of the municipality.

Resolved, That in the opinion of this association, when the same person, or persons, are interested in two or more bids made in different names, in competition for the same work, all of such bids should be rejected as collusive and against the interests of the municipality.

How to Make Unbalanced and Collusive Bidding Unattractive

This article is not a plea for or against any particular contractor or contractors, but is a plea for the universal adoption of a system of public contracts which makes unbalanced and collusive bidding unattractive by:

1. Carefully prepared estimated quantities and specifications which themselves make unbalanced bids unattractive.

2. Prompt rejection of all bids which bear evidence of being unbalanced or collusive.

3. Award of contract to the next bidder (unless there is some good, independent reason for its rejection), without readvertising, thus avoiding giving the dishonest collusive or unbalanced bidders a second chance through readvertisement.

When these simple rules are the universal practice in letting public contracts collusive and unbalanced bidding will be a practice of history only, and not till then.

Maintenance of French Roads

"They say you can tell the state of a country by its roads," says Francis W. Parker, of Chicago, recently returned from France. 'If ever I would want to go driving it would be upon the roads in France. Night after night I would go along a piece of road that was all shot to pieces and I would come back at noon the next day and could not tell it had been struck, and it is the same way with their tram cars.

"As you know the French have a wonderful system of constructing roadways. War is engineering, and the French have learned the engineering of war, and there today exist roads that I would rather go on in an outing with an automobile than on any road here, purely for pleasure, unless it was a newly built road and we had not had time to cut it up."

REFUSE COLLECTION AND DISPOSAL

Baltimore Receives Bids for Garbage Disposal as Part of General Plan for Improved Collection and Disposal of Municipal Waste

By Walter E. Lee, Water Engineer of the City of Baltimore, Maryland

The city of Baltimore has now pending before it bids which were received on April 17, 1918, for receiving, removing, transporting and disposing of garbage from all sources, and dead animals, within the limits of the city of Baltimore, for a period of eleven years, commencing January 1, 1919.

The specifications on which proposals were received call for a reduction plant having a daily capacity of 300 tons, to be operated under a "closed" system of reduction, without the emission of odors, vapor or gases. Payment to the city for the garbage and dead animals delivered to the contractor was requested alternatively on a yearly lump sum and on a price per ton basis.

Bids Received

The city of Baltimore received only one bid under the terms of the specifications, in an amount of $18,000 annually on a yearly lump sum basis, or at a bid of 35c per ton on the alternate basis. The system which was offered as being in satisfactory operation elsewhere was the "Cobwell Process," now used in the garbage reduction plants at New York City, N. Y., New Bedford, Mass., and Los Angeles, Cal.

An informal and irregular bid was also received from the Cobwell Corporation, of Cleveland, Ohio, offering to construct a garbage reduction plant using their process, of required capacity, on a city site and in city erected buildings, for a lump sum of $670,000, on which a return of 15 percent of this capital investment is guaranteed, with an additional 1 percent return for each increase of 10,000 tons annually of green garbage delivered to the plant.

Attitude of Capital Issues Committee

The city of Baltimore has withheld action on these bids pending an expression by the Capital Issues Committee of the Federal Reserve Board on the view that the Treasury Department would take toward the issuance of stock necessary to finance the building and operation of the garbage plant under the tendered bid.

The Capital Issues Committee, in a conference with officials of the city of Baltimore, indicated that it would not approve the issuance of stock or the raising of funds for any enterprise or operation not necessary for the preservation of the public health, or which would not produce a greater output or effect a greater recovery of materials entering directly into the conduct of the war, because of the raw materials and labor which would be otherwise drawn from government activities.

The city of Baltimore, in its inquiry to the Capital Issues Committee, pointed out that the present garbage reduction plant, employing the Arnold Edgerton system, is very old, and practically at the end of its operative life, effecting approximately only 2 percent of grease per ton of green garbage delivered to it, while the improved Cobwell process offered to the city under its bids will effect approximately a recovery of 3½ percent of grease.

This additional recovery of grease will produce 858,000 additional pounds of grease per annum, equal to 95,000 lbs. of nitroglycerine, used directly in the manufacture of high explosives.

The Baltimore Refuse Problem

The city of Baltimore is located on the Patapsco river, a tributary of the Chesapeake Bay. Prior to May 6, 1918, it had an area of 30.1 square miles, and an estimated population January 1, 1918, of 593,000. For waste collection purposes it is divided into four administrative districts, embracing a total of 192 collection routes.

Under city ordinance householders are required to place their garbage in one receptacle, and ashes and rubbish together in another receptacle. Prior to October 20, 1902, garbage was disposed of by the simple and primitive method of loading on scows and barging down the Chesapeake Bay a distance of six miles, and there dumping on land, but since then all garbage in the city has been disposed of by reduction under the Arnold Edgerton process, in a plant located within the heart of the city. On account of restraining injunctions granted and petitions filed on account of nuisance, the reduction plant was removed from its original location to a new site, whose barging distance is 16 miles from the city.

Under present operation of the privately owned reduction plant the grease is recovered by steam cooking for about 10 hours, under 80 lbs. steam pressure, and all grease and water is squeezed out of the tankage by Edgerton presses.

The grease, recovered without percolation, is skimmed off manually from the surface of settling tanks in series, when it is pumped to a sedimentation tank, the moisture driven off by steam coils and the grease drawn directly for barreling.

The present average garbage production of the city of Baltimore from households, markets and packing houses, is 0.58 lb. per capita per day, with a maximum of 0.68 lb. per capita daily, or 15 percent greater than the daily average quantity.

The yearly collections for the past 10 years and the monthly fluctuations in 1917, with the percentage of the maximum to the average quantities, are given in Tables I, II and III.

TABLE I—YEARLY COLLECTIONS OF GARBAGE AND DEAD ANIMALS OF BALTIMORE, MD., 1908 TO 1917.

Year	Garbage from all Sources—Tons	Number of Dead Animals	Estimated Population
1908	54,000	13,754	569,000
1909	46,900	14,637	576,000
1910	44,500	17,790	559,000
1911	48,300	19,792	565,000
1912	49,200	20,498	568,000
1913	53,400	16,561	573,000
1914	59,100	15,993	578,000
1915	61,500	11,459	583,000
1916	62,400	17,419	588,000
1917	62,300	20,178	593,000

TABLE II—MONTHLY FLUCTUATION IN GARBAGE PRODUCTION AT BALTIMORE, MD., FOR THE YEAR 1917.

Month	Tons
January	4,566
February	3,089
March	3,594
April	3,334
May	4,979
June	5,475
July	7,577
August	7,399
September	6,886
October	7,096
November	4,517
December	3,749
Total	62,261

TABLE III—PRESENT MONTHLY MAXIMUM OVER MONTHLY AVERAGE AT BALTIMORE, MD., 1913 TO 1917.

Year	Annual Quantity Tons	Monthly Average Tons	Maximum Monthly Tons	Pct.	Class of Garbage
1913	53,400	4,440	6,860	155	Household & Market
1914	59,100	4,930	6,870	140	Household & Market
1915	61,500	5,120	8,220	160	Household & Market
1916	62,400	5,200	7,360	142	Household & Market
1917	62,300	5,190	7,560	146	Household, Market & Packing House.

Ashes and household rubbish are disposed of by dumping on land, or by dumping into the waters of the Chesapeake Bay and its tributaries.

Study of Entire Problem

Early in 1916, the city of Baltimore began turning its attention to the classification, separation, removal and disposal of all classes of municipal wastes. In May of that year an ordinance was signed requiring metal receptacles for garbage and ashes, fitted with a metal top or cover, to be kept on continuously except when filling or emptying, to lessen the odors and to eliminate a feeding place of cats and rats, and the breeding of gnats and flies. In anticipation of the expiration on December 31, 1917, of the contract of 10 years' duration which the city had for the removal and disposal of its garbage and dead animals, Mayor James H. Preston made arrangements to extend the contract for a period of one year, until December 31, 1918, giving sufficient time for the writer, under his instructions, to make such studies and investigations, with recommendations in a report, as to secure better and improved separation, collection and disposal of wastes in the city of Baltimore.

The report, completed after an extensive investigation of methods of disposal used by different American cities under their particular conditions, proposed the disposal of garbage by reduction at a central reduction plant, rubbish disposal by assorting and sale of merchantable portions, with incineration of tailings, at district incinerators, and ash disposal by filling marsh lands, and dealt with the following subjects:

Method of Household Preparation

1. Primary Separation.
   (a) Garbage,
   (b) Ashes,
   (c) Rubbish.
2. Combined Collection.

The method of preparation of household waste for collection to be adopted by any community will be determined by:

A. The method of final disposal of each class.

B. The recovery of the salable merchantable portions.

While combined collections have the chief advantage of simplicity, as only one receptacle is needed for the entire household refuse, and principally used where all kinds of refuse are incinerated together, where the whole is dumped on land, or in filling low places, yet primary separation is the first requisite whenever garbage is to be finally disposed of by treatment under some form of reduction for the recovery of commercial products it may contain or where any revenue is sought from the salable merchantable portions of the rubbish.

As primary separation distributes the labor of preparation over the entire population, it was recommended that refuse shall be primarily separated by householders into three classes: Garbage, Ashes and Rubbish.

Primary separation allows the dumping of ashes with a much shorter haul than garbage, and also gives rubbish the benefit of a short haul when delivered to an incinerating station in each collecting district.

Receptacles

For best possible service, it was recommended that garbage and ashes be separately deposited in standard sanitary receptacles, uniform in size and shape, construction and material, and that rubbish be gathered and tied in bundles.

It proposed that receptacles for garbage should be:

A. Of galvanized iron, to resist corrosion,

B. 14 ins. in diameter, 20 ins. high, not exceeding one bushel capacity,

C. Slightly conical in shape, to free the contents, when dumped,

D. Water-tight, to prevent pollution of the space underneath,

E. Provided with drop handles, and a tight fitting cover, to lessen odors and to eliminate a feeding place of cats and rats.

And that receptacles for ashes should be:

A. Of galvanized iron, to prevent fire,

B. 16 ins. in diameter, 28 ins. high, not exceeding 3.5 cu. ft. capacity,

C. Slightly conical in shape, to free the contents when dumped,

D. Water-tight,

E. Provided with drop handles, and stiffened by corrugations or vertical wooden or iron strips, with iron bands at top and bottom rim.

Receptacles for rubbish can be of any convenient form and material, but preferably of galvanized iron, of the same size as for ashes, to prevent possible fire from the highly inflammable character of rubbish. In every case the rubbish should be securely bundled and fastened, or rolled up and tied, to prevent being scattered in handling, and to save time in collection.

Method of Collection

It was recommended that municipal collection of household wastes be retained, for where the convenience and comfort of the community is of first concern, and the question of nuisance is considered, the municipal collection will give a greater degree of satisfaction than any of the other four usual methods of collection:

(1) By individual service; (2) by licensed collectors; (3) by contract system; (4) by municipal collection.

The contract system for the collection and removal of garbage, ashes and miscellaneous refuse was employed by the city of Baltimore from June 1, 1901, to January 1, 1908, but the contract had scarcely been in effect one year before numerous complaints were received from citizens as to the character of service rendered, for among the general public there seems to be an opposition in having the collection of all classes of household waste done by contract, and nothing short of the City doing the work will satisfy.

The contract was therefore terminated on the last date, and the work of collecting and removing household wastes placed directly under the Street Cleaning Department, and the collection equipment purchased by the City for $372,888, and the entire working personnel practically retained.

TABLE IV.—COMPLAINTS REFERRING TO NON-COLLECTION OF GARBAGE, ASHES AND MISCELLANEOUS REFUSE, BALTIMORE, MD.
(From Dept. Street Cleaning Annual Reports)

Year	Justifiable	Not Justifiable	Total
1904	109	776	885
1905	121	710	831
1906	214	539	753
1907	172	937	1109

Advantages of Municipal Collection

The City of Baltimore owns a maximum number of collection carts which can on the average be economically and advantageously employed, hiring what additional equipment is needed to meet unusual conditions and the short maximum work period, securing the following advantages under Municipal Collection:

A. Municipality does all the work with its own equipment and employees, whose superiors are directly responsible to the public served by them.

B. Service is rendered when and where required.

C. Sanitary standard type of equipment as it is purchased is a permanent investment.

D. Responsibility for work better defined and complaints more promptly handled.

E. Public satisfaction, as service not dependent on profits.

It was recommended that garbage, ashes and rubbish be separately collected in compartment trucks and trailers, on a single joint collection trip, to supercede the two and some-

times three trips required under present methods for the same work.

Methods of Disposal

(1) Dumping on land; (2) disposal by fill; (3) plowing into soil; (4) dumping into water; (5) feeding to animals; (6) incineration; (7) reduction.

Garbage Disposal by Reduction

It was recommended that garbage, market and packing house refuse and dead animals be disposed of by reduction, for with the three separation plan of collection it is possible to have garbage yield several commercial by-products, for which there is a regular and steady market.

There are three ways in which the reduction of garbage can be accomplished:

1—Drying method: (a) dehydrating and grinding; (b) dehydrating, grinding and percolating with a solvent.

2—Cooking method: (a) rendering in open kettles and skimming off the grease; (b) digesting by steam in closed cylinders, and pressing out the grease and water, usually with additional percolation of tankage.

3—Chemical treatment.

It was recommended that the separated garbage be finally disposed of at one central plant by treatment under a "closed" process of reduction, without vapor, smoke or odors.

Private Disposal Prohibited

As the practice in the city of Baltimore is for some garbage to be given to farmers by its producers, and some incinerated on the premises, it was recommended that the incineration of garbage in any residence, apartment house, hotel or other building be prohibited by ordinance, on account of the resulting objectionable and unhealthy smoke and odor, because of the usual lack of the proper type of high temperature furnace necessary to oxidize the volatile gases and vapors driven off from the garbage during the course of destruction, so as to render them odorless as discharged into the atmosphere.

To insure all the garbage produced in the city of Baltimore being collected by the municipality and disposed of under the same treatment, so as to produce uniform sanitary results, it was recommended that the collection of garbage by the municipality be extended to cover all kitchen and dining room refuse from hotels, boarding houses, apartment houses, restaurants, saloons or any other place where food is prepared for human consumption.

This right of the municipality to collect garbage from all sources does not amount to the taking of private property without due process of law, in violation of fundamental constitutional rights, as upheld in decision of the Supreme Court of the United States in the following cases: California Reduction Co. vs. Sanitary Reduction Works 199 U. S. 306. Gardner vs. Michigan 199 U. S. 325.

Trade Wastes at Private Expense

It is not proposed, however, that the community as a whole shall be called upon to bear the expense of removing refuse from other than dwelling places, and it was recommended that the collection of trade wastes consisting of refuse materials of all kinds, including fruit skins, pea hulls, tomato skins, corn husks and cobs, resulting from the prosecution of any business, trade or occupation conducted for profit be discontinued by the city, but that such be accepted at the water front garbage dumps when delivered by private collection carts which have been licensed by the Commissioner of Street Cleaning.

In the specifications which were prepared under the recommendations of the report, it was provided that the duration of the contract should be not less than 10 years, to induce sufficient new capital to enter the field, and not over 15 years, to permit the city to embrace any important improvements which may be made in garbage reduction in the next decade, although the city should have the option to acquire the plant at the end of the contract period, on a proper basis of first cost, less depreciation, and that the plant should be located on at least 5 acres of ground on either a railway line or a navigable waterway, with a minimum capacity of 300 tons per 24 hours.

Relay Stations for Garbage Trains

The limits of Baltimore City were enlarged by an Act of the Maryland Legislature in the last session of 1918, adding 46.5 square miles to the present area of 30.1 square miles, a total of 76.6 square miles. This ever tends to lengthen the team haul of collection carts hauling garbage to a central reduction plant.

As hauls are more quickly and economically made with two or more horses or equivalent motor power than with one horse, it was recommended that the collection carts in the two farthermost sanitary districts deliver with a short haul to a relay station in each district. At each relay station it is proposed that the garbage collection carts dump over platform through chutes into three 5-ton trailers of a tractor-drawn garbage relay train, whose bodies are removed and dumped on to scows at the water front garbage dumping stations.

Ash Disposal by Fill

Ash disposal by fill was recommended as the best method for the final disposal of ashes and street sweepings, if the latter cannot be sold, as it is sanitary, free from nuisance, economical, safe and employs the shortest haul whenever possible. It was recommended that the ashes be dumped on low places and in ravines already sewered, and on marsh land to the southwest of the city, as well as on the water's edge to the Port Warden's Line in the inner harbor of the city, properly retained by piling or bulkheads for the purpose of reclaiming shoal land.

Transfer Stations for Ashes

House collection is cheapest when made with a one-horse, two-wheel cart, of 2 cu. yds. capacity, for on the average about four minutes is required in removing an ash can from one residence, dumping it, and going to the next. Except on downtown service for hotels, when wagons of larger capacity are necessary, the use of two horse collection carts generally would be to waste the services of one horse during one-half the time of collection.

With the filling of each successive dumping place, and as the outlying sections of the city are built up, the haul of the ash collection cart lengthens greatly, the average in the city of Baltimore for the four districts given below being 0.80 miles.

TABLE V—AVERAGE LENGTH OF HAUL FOR DISPOSAL OF ASHES AT BALTIMORE, MD.

Central District	0.90 miles
Northern District	0.73 miles
Western District	0.85 miles
Southern District	0.70 miles

To keep the length of haul of the ash collection cart as nearly fixed in distance as possible, it was recommended that loading stations for ashes be erected in those districts where it is cheaper to transport ashes in 8 cu. yd. removable steel bins on flat trolley cars than to continue the direct collection cart haul. It is proposed that the ashes will be dumped from an elevated platform through chutes into the steel bins on street railway cars underneath.

On account of the escape of ash dust and odors arising from the present water front garbage and ash loading stations during the hot dry summer months, it was recommended that these water front stations be housed in a super-structure with an induced draft system, to prevent nuisances of dust and odor.

Where ashes are to be spread over marsh land or on the water's edge along the harbor for the purpose of reclaiming land, it was recommended that belt conveyors and locomotive

cranes be more generally employed in the unloading and distribution of ashes at such dumps.

Rubbish Disposal by Incineration

Rubbish contains from 25 to 50 per cent of merchantable articles, which can be recovered as revenue by sorting and picking. It was recommended that this sorting privilege for the sorting, picking and removal of the valuable portions of the rubbish, including rags, rubber, metals, bottles, etc., be annually awarded by contract to the highest competitive bidder.

When rubbish sorting is performed by a contractor, who pays for the privilege of doing so, and is carried on at established points under the city supervision, it will prevent materials which have been discarded by the householder from being dragged back into the city and stored in the back yard or cellars of persons recovering it, not because there is any use for it, but simply because it has an intrinsic value. Where the sorting privilege is not sold by the city and carried on under city supervision, but scavengers allowed to salvage this cast off material from a community, we have on the one hand a portion of the population discarding things which are no longer of any use or value to them, while another portion carries it back into the same place from whence it came.

The remainder of the rubbish, which has no value, was recommended to be disposed of inexpensively and sanitarily by burning in a small district incinerator, erected in each of the four sanitary districts, at the ash receiving and transfer stations.

Unsalable combustible rubbish produces less than 10 per cent of its original weight burned, and while incinerator ash and non-combustible rubbish must be finally disposed of in the same manner as household and factory ash by hauling to the dump, the net saving is 90 per cent of the cost of the otherwise direct haul of the unincinerated rubbish to the dump, less the cost of incineration.

Utilization Station and Incinerator

It was recommended that the rubbish utilization station for the recovery of the valuable portions should be built integral and as a component part of each district incinerator. The proper sorting of rubbish requires the material to be delivered to the station free from garbage and to be fed upon an endless conveyor, from which persons on either side pick out the marketable articles and throw them into classifying gravity bins. Power presses are used for baling the different classes of articles recovered. The remaining unsalable and unrecovered rubbish remaining on the conveyor is carried directly to the incinerator, where it is destroyed.

Location of Utilization Station and Incinerator

It was recommended that the utilization station and incinerator be erected as nearly as possible near the center of gravity of each of the four sanitary districts of the City of Baltimore, so that the haul to it by the collection carts would be the shortest. The center of gravity is not the geographical center of the district, but it takes into account park and cemetery areas, from which no collections will ever be made, as well as the irregular shape of each district.

Whenever possible, the incinerator should be located on a hillside or on a street with steep grades, so that rubbish may be delivered directly by the collection cart on the upper level, and the incinerator ash may be removed from the lower level, without any elevation of it.

The cost of delivery of rubbish to the incinerator is made up of the cost of collection and the cost of hauling to the incinerator after the collection cart is filled, but the cost of collection does not depend on the central location of the incinerator, while the cost of hauling does.

The geographical location finally selected will determine the type of architecture of the incinerator, which should be erected in keeping with its surroundings.

Capacity of Incinerator

Average rubbish production for the City of Baltimore is approximately 0.20 lb. per capita daily, with a maximum of 0.224 lb. per capita per day, or 12 per cent greater in the spring and fall months than the daily average quantity. It was recommended that the four district incinerators, each having a capacity of 40 tons per 24 hours, be erected at an approximate total cost of $160,000.

It was also recommended as an improvement in collection equipment that a gasolene driven vacuum cleaner with dirt storage trailer be purchased and used in cleaning during dry weather of down town business streets paved with sheet asphalt, and that all present wooden collection carts, as they become useless, be replaced with steel carts having combination ash and garbage compartment body, fitted with semi-cylindrical covers and sliding dumping lever fastened to the side.

FROM WORKERS IN FIELD AND OFFICE

How a County Engineer Builds Small Culverts and Bridges

To the Editor: I bought a Model 17 Wonder concrete mixer about a year ago, used it last year, and will give you my experience with it, as perhaps it will help some one else with their concrete work. The mixer is complete, with a loader, and rotary pump to supply the water. It is all mounted on a truck, with a total weight of about 3,200 lbs. We use it on all kinds of work from a tile culvert with a concrete jacket, taking about six or seven sacks of cement, to a large culvert or bridge, taking 435 sacks of cement. The latter is the largest job we have yet used it on. It has proved to be the biggest labor-saving machine that I have ever used, and in my judgment no road official can afford to mix concrete by hand. The mixer not only saves time in mixing, but it also saves man power, which is a big item at the present time. With a suitable mixer the concrete can be mixed and placed in the forms at a cost not exceeding one-half of what it would cost to mix it by hand.

As to the crew necessary to operate the mixer, it depends on the work. On large jobs, where you want to operate the mixer to its full capacity, the crew should consist of ten or twelve men besides the foreman. The best work that I have ever done with our mixer was with a crew of ten men besides the foreman. The concrete was wheeled in barrows from 20 to 100 ft. from the mixer, three men doing the wheeling. When we mixed and placed 130 sacks of cement in three hours the men were used as follows: Three men to load the mixer, one to operate the mixer, one to haul water, three to wheel the concrete away from the mixer and two to place the rein-

forcing and tamp the concrete. In building tile culverts with concrete jackets, in which the amount of cement used will run from 6 to 12 sacks, I generally use one water hauler (who also moves the machine from one job to the next), one or two loaders, one man to operate the machine and one or two to help the foreman place the concrete and tile. I have used it with only three men besides the man with the team.

As to the best size of machine, every one will have to be governed in this by the conditions under which he is going to use it. If the work will not take more than 100 sacks of cement to the job I would advise the purchase of what is known as a half-sack batch machine, but if the work is like it is here, where you will use from six sacks up to 1,000 or 1,500 sacks, I would not advise buying smaller than a sack batch machine. If the work is all large jobs, from 100 sacks up, buy a still larger machine.

Method of Building Small Culverts

The following is the best method that I have ever tried for building small culverts where we use No. 2 drain tile with a concrete jacket, and which takes from 6 to 15 sacks of cement, according to size and length. I first have a crew dig the trenches across the road for the tile, making them about 7 or 8 ins. wider than the outside diameter of the tile, and then place a temporary wooden top over them. After everything is ready I take my crew and mixer and drive up to the place for the culvert, set the machine so that it will dump the batch into the trench for the culvert, then remove the wooden top, clean out the trench, place about 3 or 4 ins. of concrete in the bottom, then place the tile, being careful that it is laid straight and of even grade, then finish up with about 4 or 5 ins. of concrete on top. Good concrete headers should also be placed and raised just high enough to hold the fill for the road at each end of the culvert. Then backfill the trench and you are ready to go to the next job and repeat the operation. After you get used to the work you can build one in 30 minutes' time. We have used the above type of culvert or drains for openings less than 2 ft., i. e., No. 2 farm drain tile with a concrete jacket, for the last two years, and they have given good satisfaction and it is the cheapest permanent drain that I can find.

Very truly yours,

S. C. Knight,
Tuscambia, Mo. County Highway Engineer.

Using Motorcycles in Municipal Service

To the Editor: The highway section of the Department of Public Improvements of the city of Baltimore have used Harley-Davidson motorcycles for about 4 years. At present there are 5 in use. These are being used in the repair division by assistant engineers, who use them in going over their districts. By using the motorcycle the assistant engineers are able to inspect their territory daily. These engineers also supervise their street repair forces during the day and note the progress being made.

The guaranteed street division uses another Harley-Davidson motorcycle for practically the same purpose as the assistant engineers in the street repair division. The Bureau of Complaint uses a motorcycle also. The work of that bureau is to investigate all complaints and report them to the proper department.

The resident engineer of Baltimore, of the Maryland State Roads Commission, operates one of these motorcycles, with side-car equipment, on his inspection tours. The chief plumbing inspector of the city of Baltimore also uses one of these motorcycles.

We have found that by the use of these motorcycles the streets can be gone over more thoroughly and more frequently than was the case previously when street cars were used and the men had to do considerable walking.

Very truly yours,

R. Navin Cooksey,
Baltimore, Md. Highways Engineer.

Proposed Road Improvements in Arkansas in 1918

To the Editor: The Arkansas road building program calls for an expenditure of $15,000,000, covering about 2,500 miles of road, but we will not be able to construct that amount owing to present conditions. We have 129 districts organized in 56 of the 75 counties of the state, but we can't tell how many will be passed by the Capitol Issues committee when the bonds are ready for passage.

Most of our roads are gravel and macadam, however, the greater portion of the Arkansas-Louisiana highway, which is 168 miles in length and the largest individual project in the South at the present time, will be asphaltic concrete on concrete base. The actual bond money which is being used in the state for construction of roads at the present time amounts to $6,371,865. This money is distributed in districts in the several counties in the state, covering a mileage of 706.5 miles. The contract price of this work amounts to more money than the bond sales noted above, but this difference is covered by federal and state appropriations amounting to $630,776.

Very truly yours,

J. E. Fry, First Ass't. Engineer,
Little Rock, Ark. Arkansas Highway Commission.

More Home Grown Food Via Rural Motor Express

To the Editor: The market garden area of every city may be greatly extended by establishing Rural Motor Express lines for the hauling of farm products. This fact has been demonstrated by surveys made by the Highways Transport committee of the Council of National Defence. This committee is co-operating with the Federal Food Administration in the

MOTORCYCLES USED IN ENGINEERING WORK AT BALTIMORE, MD.
Left: Motorcycle with Side Car Used by Resident Engineer, Maryland State Roads Commission. Center: Assistant Engineers, Department of Roads and Streets. Right: Chief Plumbing Inspector.

campaign to secure the utilization of more home-grown perishable foods produced in the vicinity of the point of consumption. This matter is being handled through the state food administrators and state councils of defense.

In a circular to the various state committees appears the fqollowing:

"The ordinary market-garden section of most of our cities is confined to an area with a radius of 20 miles or less, since that is about the limit of the distance from which farmers can haul produce to a public market with teams and make the best use of their time. Produce coming from greater distances must be shipped over the railroads. The congestion of traffic this year, with local freight embargoes in many instances, has blocked and delayed the shipments of foodstuffs, even though these were not included in the embargoes since crowded terminals are the chief cause of the delays.

By using the motor truck the farmers are able to operate vegetable farms successfully at distances from 30 to 40 miles from market, because of time saved in trips to market. Much produce is the by-products of general farms, and the rural motor express offering daily service to and from market collects these small lots of fruits, vegetables, eggs, butter, etc., and brings them to wholesale districts in good condition. In every locality in which regular service of this character has been established there has been an increased production of perishables.

This expansion of area from which the city may draw perishable products is one of the three most important reasons for a wider adoption of motor farm transport. Summarizing the arguments the main points in favor of Rural Express are the following:

"Labor is saved on the farm by relieving the farmer of his market hauls, permitting him to remain in the fields with his teams during the busy season.

"Transportation delays are avoided since the railroads are relieved of a large volume of short haul traffic at every produce market terminal, where the congestion is particularly great.

"The proportion of home-grown foods available to city is greatly increased by the expansion of the area within which farmers can properly conduct market-garden farms and get their own product to market in the best condition.

Very truly yours,
HIGHWAYS TRANSPORT COMMITTEE,
By J. Clyde Marquis, Rural Express.

Washington, D. C., June 11, 1918.

War-Time Financing of Permanent Road Construction

To the Editor: If you were to be asked what development, in your judgment, would make it the easiest for the country to pay its war debts and reduce the taxes imposed by the war, what would be your answer? Can you think of a better one than to say: "Sufficient expansion in permanent road construction"?

This being true, is it not entirely practical to launch, throughout the country, before the next bond issue, a movement for the creation in every locality of a special fund (whether large or small), made up exclusively of liberty loan bonds, to be held in trust by local commissions, for assisting in the future in permanent road construction? Here the commission for this purpose consists of the president and secretary of the chamber of commerce and chairman of the road department, and a fund is being formed which, from the initial contributions, pledges and interest shown, demonstrates that the work can be given the character of an important war service as well as for future road construction. The enrollment here is in clubs of 100, each club contributing a bond, with larger individual pledges following.

Will you not take pleasure in giving publicity to this movement, and in personally pushing it along in any of the various ways which will suggest themselves to you?

Yours truly, F. F. MURRAY,
Titusville, Pa. Editor of *Along the Way*.

Laying Water and Sewer Connections in the Same Trench at Waltham, Mass.

To the Editor: In Waltham, Mass., city employes lay the sewer and water connections from the mains to the inside of the foundation wall of the connected building, so that it is comparatively easy to secure the care in laying which is very necessary where the water and sewer pipes are put in one trench.

1. Care in backfilling is easily specified, but it is hard to secure. It is very necessary.

2. The lead connection with the water main is invariably employed. This gives considerable flexibility and takes care of some settlement.

3. Usually the water and sewer pipes are laid at the same grade, to go in at the bottom of the cellar, and all danger from settlement is eliminated.

4. When there is a difference of grades of more than a foot, planks 6x2 ins., are laid transversely across the ditch underneath the upper connection. These are spaced not more than 8 ft. apart.

5. The two lines of pipe are separated as much as possible and 6 ins. is the minimum space allowable.

The question of a new or improved supply of water is a very important one for Waltham.

Very truly yours,
BERTRAM BREWER.
Waltham, Mass. City Engineer.

PLANT UNITS AND LAY OUTS

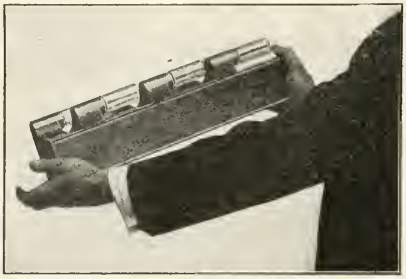
Universal Sand Tester

The Universal sand tester here illustrated and described makes easy the testing of sand on small jobs. The importance of sand testing in concreting operations has been long understood, but was usually neglected except on large undertakings where laboratory facilities were available.

The value of sand in concrete work depends upon the grading of the grains and upon the cleanness of the grains. The tester determines the grading and gives an indication of the cleanness. The apparatus consists essentially of a graded series of standard mesh screens, Nos. 6, 10, 20, 35 and 65, in a water tight casing, a series of glass vials communicating with the screens, and means for holding and making a graphical record of tests. In operation, the tester is simple.

First a small metal measure is filled with the sand to be tested and emptied into the casing through an opening in one end. Through the same opening water is then poured until is shows above the first screen. Then holding the tester between the hands, vial-side up, a reciprocating motion is given to the apparatus, with the impulse toward the downward end of the stroke. This produces a wave action in the water, which causes a separation of the sand-particles.

The tester is then turned vial-side down and the materials are washed from the screens by gently shaking the apparatus. The tester is then turned into a vertical position, when the materials flow into glass vials. A gentle shaking suffices to deposit all the materials. The record sheet is then placed on the platen, and by successive placing of the index at the top of the sand in the successive vials, and by drawing a pencil line along the index across the record sheet each time,



VIEW OF UNIVERSAL SAND TESTER.

and by placing this pencil line successively level with the bottom of the next succeeding vial, the record sheet is formed, either singly, in duplicate, triplicate, or as desired.

This not only completes the grading, but gives a permanent graphical record of it. The operation can be performed by anyone who makes the easy acquaintance of this apparatus.

The record sheets are furnished in three different styles: a plain sheet on which the user may establish the standard of values his sand should follow, a double record sheet, a duplicate of the former, perforated and of such quality that carbons can be made at one operation, when duplicates are desired, and a heavy record sheet banded in red to indicate the location of the theoretical gradings for maximum density of mixture.

In addition to its use in connection with concreting operations, this sand tester is well adapted for measuring the size and uniformity co-efficient of water filter sands. The percentages passing the screens and the screen sizes can be read at a glance, thus avoiding the laborious plotting of determined percentages, as is necessary by the ordinary laboratory method.

The sand tester is sold by Kolesch & Co., 130 Fulton St., New York City.

Successful Use of Kerosene Torches in Removing Ice from Railway Tracks

Ten Chausse kerosene torches are in use on the lines of the Chicago & Oak Park Elevated Railroad Company, and they were found of great aid in the severe snow and sleet storms of last winter, according to B. J. Fallon, engineer, maintenance of way. The snow was swept from switch points and then the torch used to thaw out the ice which froze in the fittings and which is always the hardest part to get clean.

Interlocking pipe line carriers and leads were freed from ice in the same way. The flame will go where it is next to impossible to get any kind of tool. Frozen water pipes at stations were thawed out at less than half the usual cost and with less damage to them.

In keeping the complicated special work on the Union loop free the torches were invaluable. This track is all guarded and the snow packs into the pockets and soon forms ice.

"I am a thorough convert to the usefulness of these torches," says Mr. Fallon.

This torch, distributed by the Alger Supply Company, of Chicago, only, is here illustrated in operation. It produces a clean flame, great heat, can be used in any position, and does

CHAUSSE KEROSENE TORCH IN OPERATION.

not carbonize. This type of torch is also much used for preheating for acetylene welding. The kerosene torch produces a hotter flame than a gasoline torch at much less cost.

In addition to thawing ice from switches, the railroad mentioned has used these torches for removing dangerous ice and moisture from station steps and platforms and for thawing out frozen plumbing around the elevated stations.

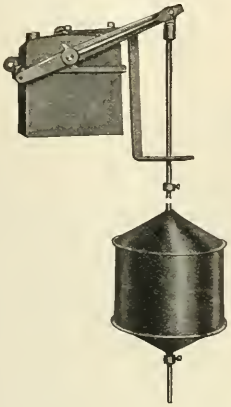
An Enclosed Float Switch for Remote Control of Pumps

In the remote control of pumps such as pumps in the basements of buildings and pumps serving water towers in villages and towns, the pumps and motors receive very little attention, and the float switch still less when the motors are started and stopped by such a device. As long as the water gauge shows a good supply of water the attendant will not trouble himself to know whether the float switch is covered with ice and dirt or whether the operating mechanism of the switch can operate properly. Overflowing of water tanks and towers are not uncommon occurrences.

Realizing the lack of attention given to float switches and the severe conditions under which they must operate, the Cutler-Hammer Mfg. Co., of Milwaukee, has developed an enclosed weatherproof float switch, here illustrated, built so heavy it will stand considerable abuse and with an operating mechanism that will positively open and close with the rise and fall of the float. One of the chief objections to some switches is that they get out of step, if for any reason the switch fails to latch in. This happens through the contacts becoming badly burned, which prevents the blade from entering the clips. Or, where the blades become bent out of adjustment the same result follows. When the latching mechan-

ism of such a switch gets out of step, the switch opens when it should close, and vice versa. The design of the new C-H switches make this impossible. The switch can only be open when the lever is in one position and only closed when in the opposite position.

These switches are furnished complete with a sheet copper float having conical ends, float rod, and a heavy float rod guide. Conical end construction is used on the copper floats which gives greater strength than flat ends, and there is less chance of the float opening at the end seams. Various mounting and controlling arrangements are furnished. The single pole switches are intended for use in connection with a starter for controlling A. C. or D. C. motors. The 2- 3- or 4-pole float switches are designed for single phase self-starting and polyphase squirrel cage motors, which may be thrown directly across the line to start. They can also be used for direct current motors when used with a suitable self-starter. These multipole switches have a maximum capacity of 5 h.p. at 110 volts and 7½ h.p. at 220, 440 or 550 volts.



C-H ENCLOSED FLOAT SWITCH FOR REMOTE CONTROL OF WATER PUMPS.

Kirstin Method of Removing Stumps

The Kirstin method of removing stumps is illustrated in the accompanying half-tone. The cost of doing this work is comparatively low. One of the most important demonstrations of the Kirstin method yet made was at the University of Wisconsin last season in showing farmers how easy it is, and how inexpensive, to clear the logged off land in that state. This demonstration was held under average conditions. The stumps in some places were thicker than is usually the case and in other places the stump tops were too rotten to pull to best advantage, but taken as a whole the conditions were average.

Four tests were made. In the first, 118 stumps, ranging from 4 to 28 in. in diameter, were pulled in 6 hrs. and 40 min.; in the second test 62 stumps, from 6 to 36 in., were pulled in 2 hrs. and 30 min.; in the third test 145 stumps, 5 to 42 in., were pulled in 6 hrs., and in the fourth test 164 stumps, 4 to 36 in. in diameter, were pulled in 6 hrs. Three men and a team cleared one acre in each of the above cases. The puller is compact and light enough so that it can be handled with ease and rapidity. It is claimed that a puller of this type will handle 98% of the stumps ordinarily encountered.

VIEW OF KIRSTIN STUMP PULLER IN OPERATION.

Using an All-Smokeless Outfit in Repairing Asphalt Streets

An asphalt repair outfit, including machines of five different types, all of which were smokeless, is here illustrated. This outfit was recently employed on Michigan Boulevard—the principal show street of the city of Chicago. In this locality it was, of course, highly desirable to eliminate smoke, fumes and ashes usually associated with old types of equipment employed on asphalt pavement repair work. The outfit illustrated accomplished this result beyond question and much to the satisfaction of the Department of Streets and of the owners of the property abutting on the street where the work was being done.

VIEW OF SMOKELESS EQUIPMENT USED IN REPAIRING ASPHALT STREETS IN CHICAGO.

The view shows two tandem motor rollers of Austin-Western Road Machinery Company manufacture, a Phisto tool-heater and a Pluto surface heater of the Chausse patented type, distributed by the Alger Supply Company of Chicago, and a Zin-Ho portable air compressor. Two motor trucks used in hauling the hot asphalt to the street are also shown.

On this work the surface heater was first used, then the portable air compressor was used to cut out the portion of the asphalt that needed replacing. The hot asphalt was then added from the motor trucks and ironed and smoothed with the hand tools heated in the tool heater. The freshly deposited asphalt was then rolled by means of the tandem motor road rollers. These road rollers have powerful engines that run steadily and smoothly. They are easily controlled and steered. They have two gear speed changes and their operation is entirely free from smoke, sparks and ashes. They are free from boiler troubles and repairs and do not require the teaming of coal and water; thereby keeping unsightly equipment off the street entirely. Property owners are very appreciative of equipment of the type shown in this view.

GENERAL ARTICLES

Modern Highway Danger Signals

By A. G. Shaver, Consulting Electrical Engineer, 857 Peoples Gas Building, Chicago, Ill.

That some sort of warning signal, or an alarm, with a visible indication, suitable for governing highway traffic at night over railroad grade crossings, is desirable, has long been recognized. And that this visible indication should be of an animated character is apparent from the fact that it has been a feature of nearly all such signals installed.

Bell Signals Are Obsolete

About 1899 some crossing bells were installed with an incandescent light attachment such that it gave a flashing light shining out at night along the highway. This was not regarded as very successful, however, because the lamps would soon burn out and the cost for battery renewals was considerable; so this lighting feature was not generally used.

HIGHWAY DANGER SIGNAL OF A. G. A. TYPE INSTALLED BY INDIANA UNION TRACTION CO. AT CROSSING OF ITS ANDERSON LINE WITH ORCHARD AVE., A HIGHWAY, JUST OUTSIDE OF INDIANAPOLIS.

For some years considerable progress was made in developing automatic highway grade crossing alarms, and a very large number were installed by the railroads, but, practically without exception, they were audible alarms of the bell type.

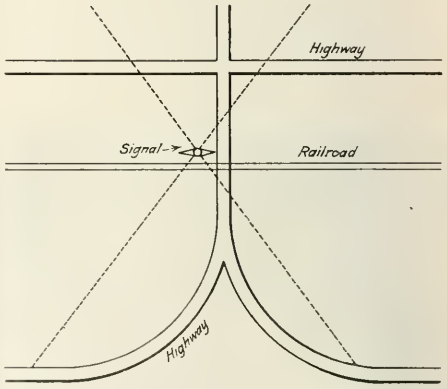
Developments in Highway Signals

With the automobile coming into general use, it was found that often the noise of the motor drowned the sound of the crossing bell so the driver of the car could not hear it. Then there appeared in the market a visual signal of the swinging flag type, and to these, a little later, was added a lamp for the night indication. Such signals are still much used, but they are relatively expensive as to first cost, and, if properly maintained, require considerable attention.

The A G A Signal

Lately there has appeared in the market a new type of signal, or illuminated sign, patterned after the well-known flashing light used so much in buoy and lighthouse equipment for guidance of ships. Such a signal is shown in Fig. 1, and was furnished by the A G A Railway Light and Signal Company, of Elizabeth, N. J., to the Indiana Union Traction Company, which installed it at the Orchard avenue crossing, near Indianapolis, Ind.

This signal operates continuously, flashing out a red light through the Fresnel lens at the center and illuminating the word *railroad* in the transparent case of the lantern. The Fresnel lens gives the red light a spread of 60 degrees. In the daytime this red light may be seen at a distance of several hundred feet, and at night it may be seen several thousand feet. The word railroad is distinguishable for a dis-



SKETCH PLAN SHOWING SIGNAL AND SURROUNDINGS AT INSTALLATION SHOWN ON THE LEFT.

tance of 200 to 300 ft. The animated character of the signal compels attention from approaching vehicles on the highway, and also it is not confused with any other lights which may be in the vicinity.

Fig. 2 is a diagramatic view of the situation when the signal shown in Fig. 1 is installed, the broken lines indicating the limits of the spread of the red light. This signal has been in operation about four months. Within that time it has not

TYPICAL INSTALLATIONS OF THE A. G. A. SIGNAL.

required any attention, and it will continue to operate about six months longer before the supply of acetylene gas will need to be renewed, and when renewed the gas will cost about $4.50.

This signal was designed for protecting dangerous places in highways, but it is working out equally well for protecting railway crossings.

Safer Safety Islands Will Result from Improved Design

By G. S. Eaton, Chicago, Ill.

Dangerous safety islands at street intersections are not so unusual as one might think. In the few years that have elapsed since increasing motor car traffic made necessary their construction no carefully considered design has been generally adopted. Instead, very few of the many different types which are found indicate that thought has been given to eliminating dangerous features. Any barrier such as a safety island, when placed in a busy thoroughfare, invites accident unless designed with care. To make safety islands more plainly visible and as near collision-proof as possible should be the effort of every official in charge of parks or boulevards and the concern of every pedestrian and motorist.

Accidents Occur Despite Present Safety Islands

That safety islands as constructed at present are not safe is shown by the frequency with which accidents occur. In Chicago there are 153 islands under the control of the South Park Commissioners. At these islands 270 accidents occurred in a year's time. On the North Side two broken island lamp posts were noticed not far apart, on one boulevard, during a short tour made some time ago over several of the North Side drives, as shown in Fig. 1.

One of the smash-ups occurring on Chicago's West Side is seen in Fig. 2. In this accident a costly lamp post was broken and the automobile was damaged. Improved design will eliminate many of these accidents and reduce the danger and property loss in others.

Poor Illumination Often Responsible for Accidents

Poor illumination is responsible for many accidents. Safety islands should be constructed so that not only the careful motorist will see them, but so that the careless driver cannot fail to note their presence. It is often difficult at night for the approaching motorist to determine the extent of the island platform where no special thought has been given to properly designing the island.

Making Islands More Visible

A simple way of correcting this dangerous condition of poor visibility is to illuminate the base of the island with white light. Bulbs placed just below the red signal and shielded with reflectors which are open at the bottom will furnish the desired illumination without blinding the motorist. The accompanying drawing shows a design which includes this feature.

Another means of making safety islands more easily visible is the use of white posts. When safety islands were first constructed black posts were thoughtlessly adopted because of their general use in street lighting. Black absorbs light; white reflects it. In Chicago the South Park Commissioners last year had most of their island posts and platforms painted white—see Fig. 3. A few months ago similar action was taken by the Lincoln Park Commissioners, who had only the posts painted white.

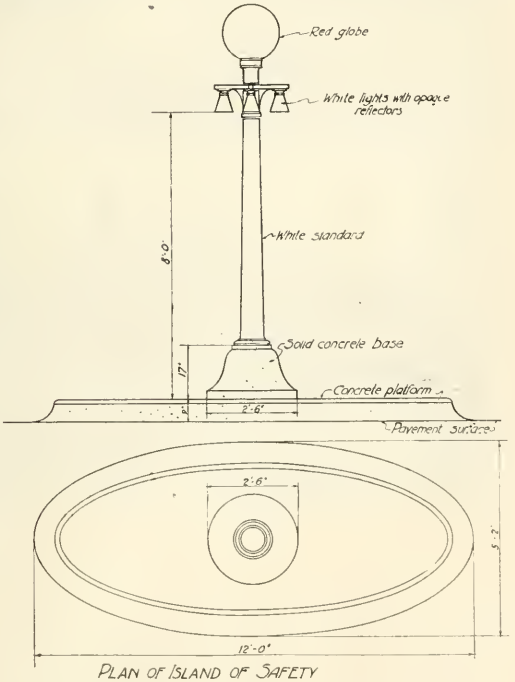


FIG. 5—SUGGESTED DESIGN FOR SAFETY ISLAND.

Substantial Barrier Is Requisite

Aside from the improvements just considered, there are other ways in which safety island design should be bettered. One important function of safety islands is to provide a place where pedestrians can stop without fear of being struck by motor cars. In order to protect pedestrians properly, a substantial barrier must be constructed—one of such a nature that an automobile colliding head-on will be stopped, stopped without breaking the lamp post, if possible, so that flying glass and the falling post may not increase the chances of injury.

Provision for Glancing Blow

In many accidents the island is struck a glancing blow. Careless driving, skidding or failure to see the island may be responsible for the mishap. At times, colliding with the island is the only alternative to running into another car or to striking a pedestrian. Since the second important purpose of safety islands is to fix lines of traffic, it is not surprising that occasionally on much traveled thoroughfares misjudgment should result in too quick turns at safety islands, or in insufficient allowance for clearing them. In all such cases it is essential that the platform and lamp post be so shaped that the automobile will be veered off, thus preventing an accident, with its attendant property loss and possible injury to occupants of the car and to those seeking refuge at the island. will reduce the property damage and the number of injuries resulting from collisions. These improvements or others similar in nature should be incorporated in future safety island designs.

VIEWS ILLUSTRATING GOOD AND BAD SAFETY ISLAND DESIGNS.

Fig. 1—Accidents Occur Frequently at This Intersection. Fig. 2—One of Many Collisions at a Chicago Safety Island. Fig. 3—Safety Islands Fix Lines of Traffic. Fig. 4—White Posts Easily Seen, but Two-Color Globe Not Satisfactory.

Thought was given to the proper shape for an island in working up the suggested design, which is shown herewith in Fig. 5.

In foggy weather a dark object may be seen more easily than one of light color. For this reason, as well as because of the desirability of a dark red light, a red globe is preferable to one of white glass with red bulbs inside. When the red globe is used, it furnishes a color contrasting in daylight with the white of the post. Two color globes, red above and white below, have been tried for indicating danger and lighting the base at the same time, but they have not been found satisfactory—see Fig. 4.

Since accidents are of such frequent occurrence at safety islands, it is evident that efforts to decrease their number are needed. Simple improvements have been pointed out which will make safety islands easily seen, day or night, and which

Trade Notes

On Friday and Saturday, May 24th and 25th, the Service Motor Truck company held a convention of district sales managers in Chicago. The following representatives of the company were in attendance: E. T. Herbig, sales manager; L. A. Poundstone, eastern district sales manager; Henry Wolf, central district sales manager; F. A. Drage, northwestern district sales manager; B. W. Plage, southwestern district sales manager; G. E. Glaser, southern district sales manager; F. E. Norman, Pacific coast district sales manager; L. H. Brown, factory representative, and M. E. Stoner, assistant southern district sales manager. The meeting was held in Chicago rather than at the factory at Wabash, Ind., so that an inspection might be made of the Buda Motor company's plant at Harvey, Ill., Buda engines being used in all Service models.

Coming Conventions

July 13.—Northwestern Society of Highway Engineers; secretary, C. G. Reiter, Hillsboro, Ore. Quarterly meeting at Portland, July 13.

Oct. 2-4.—American Society of Municipal Improvements; secretary, Charles Carroll Brown, 304 E. Walnut St., Bloomington, Ill. Annual meeting at Buffalo, N. Y., on Oct. 2-4.

EDITORIALS

How Are the Plans Progressing?

Months ago it was strongly urged that cities take advantage of the lull in construction to bring all their engineering records down to date, and to prepare plans for public improvements to be built after the close of the war, or perhaps before that time. It is known that some cities are following this program, but it is suspected that all are not doing so. Cities that are not laying careful and comprehensive plans for future construction work are slacker cities. They are remiss in their duty to their own citizens and to the nation.

After all has been said and considered, the surest thing we know is that there will be a construction boom of unprecedented proportions as soon as the war ends. All engineers, all manufacturers and all economists hold confidently to this view. The logic of events will lead to this construction era. The present rather general postponement of improvement enterprises is storing up a great volume of construction work which will be released when the war ends. All the precedents point in this direction. There can be no reasonable doubt on this point. It is inexcusable for any set of city officials to procrastinate further in planning these improvements.

Cities that do not plan now will of necessity plan hastily at the close of the war. Half-considered plans will be hurriedly executed to the permanent disadvantage of the city that did not plan in time. Now, there is ample time for careful planning, and the best talent can be secured. In the nature of things so many cities will wait for the return of peace before doing anything that the best engineering talent will then be overwhelmed with work and will be obliged to turn down many opportunities. Important planning will be entrusted, then, to relatively inexperienced engineers who will probably command higher fees than the very best engineers would ask in these times.

What we have said is predicated on the assumption that construction will boom after the war but not before that time. We have kept on the most conservative ground. But there is another reason for planning now and that is that there may be more construction before the end of the war than now seems likely. The end of the war may be far off and many cities now determined to do nothing until that time may change their programs as month after month passes without seeing the end of the war. Improvements cannot be postponed indefinitely and probably will not need to be so postponed. Cities may want plans sooner than they now think likely and may want them badly, either to provide an improvement that cannot be longer deferred or to relieve a condition of unemployment.

Unpreparedness for war has cost us much, both directly and indirectly. The folly of military unpreparedness is now generally admitted. But this is only one form of unpreparedness. There are other forms of business and industrial procrastination that are enormously costly in the long run, though lacking the dramatic interest of military affairs. To refrain from making plans now is to be unprepared for peace which is even less excusable than being unprepared for war. There was a chance, if but a slight one, that we should not have war, but there is no chance that peace will not return. Cities should prepare for peace now. The elementary, time-tried and universally approved method of preparing for peace is to have ready for launching at any time a comprehensively planned construction program.

City officials who fail to plan now cannot hope to escape the most bitter criticism when the plans are wanted. They will be held guilty of totally inexcusable shortsightedness if not of gross stupidity.

When Contractors' Bids Are Too High

The financial hazards in the contracting business, always great, are growing greater. With this increase in the money risks of the contracting business the contractors, naturally enough, are becoming more and more cautious about assuming the risks imposed by a contract. Consequently, some contractors are raising their bids to cover all known contingencies and all the others they anticipate or fear. The result of this method of price fixing is that many bids are being rejected because too high. In some cases officials feel that the bids are disproportionately high, even considering all the uncertainties now surrounding the carrying on of construction work. What is the remedy for this condition of affairs? First, readvertise for bids and if they are still too high, perform the work by day labor where this can legally be done and where the improvement is considered essential.

A situation of this sort in Illinois has attracted attention and serves well as an illustration. Bids were submitted for the construction of certain sections of the Dixie and Lincoln Highways, as a part of the Federal Aid System, for which funds are available, but were rejected because they were too high. There were no bidders on a number of sections and on several other sections the bids appeared excessive, to the state officials, even under existing conditions.

In rejecting the bids a statement to county boards and highway officials was given out by officials of the State Department of Public Works and Buildings, in which contractors were absolved from blame for the high bids. The portion of the statement bearing directly on this point was as follows:

"Because of the uncertainties of the situation brought about by war conditions no blame can be attached to contractors. Contractors are obliged to take into consideration many things over which they have no control, among which are the following: The liability of a wide variation in the cost of labor; possible difficulty of obtaining labor at any price; impossibility of determining the cost of materials; difficulties likely to be encountered in transportation because of shortage of cars; and, possibility of further advance in freight rates."

The department, at the time of writing, is making an investigation in conjunction with the Federal authorities to determine whether these Federal aid roads should be considered of sufficient importance for the movement of fuel, crops, munitions and other war

materials to warrant their construction by the state itself.

Certainly the state should take up this work. The improvement of the sections in question would give a good road usable every day in the year throughout the entire length of the Dixie and Lincoln Highways in Illinois. These improved roads would be of great economic value as an aid to transportation, inasmuch as they would connect important centers of production of both agricultural and manufactured products.

In building up organizations for emergency construction work by day labor, in circumstances similar to the foregoing, existing construction organizations might well be utilized. In this case no question was raised as to the ability of the contractors to carry on the work successfully; the only question was one of price. As the price was too high because of risks an individual dared not assume, why not let the state assume the risk and let the contractors' organizations carry on the work? This does not mean a cost plus contract, necessarily. The organizations should be drafted by the state, if the contractors agree to this course, and should work under their own foremen and superintendents. The contractors themselves might well be engaged, at adequate salaries, to assume general control of construction operations.

By following this course the state will promptly secure the roads it needs most and will get them at a minimum cost; construction organizations, which are a great economic asset to the state, will be preserved intact, and individual contractors will be safeguarded against financial ruin, while enjoying useful employment. This may not be a 100 percent winning combination, but has anybody a better suggestion?

Government Boards Should Differentiate Carefully Between Country Roads and City Streets

The engineer of pavements of a great city has called our attention to the seeming lack of experienced street paving engineers among the advisors of the Federal Government on highway matters. It seems that the highway departments of the various states are the local agencies through which the government control of paving is exercised. Most of these departments are new, and while not necessarily inexperienced in road work are, as a rule, unfamiliar with street paving and urban work.

Our correspondent suggests that the Highways Council have properly qualified local representatives in all states or large cities, familiar with city paving problems and willing to report as to the economic merits of any projected improvement. This would be far better than to compel interested parties to spend considerable time and money in visiting Washington so frequently.

Federal agencies, with authority in the premises, have in some cases shown a disposition to halt construction operations under way on a system of street paving because of an alleged shortage of asphalt or asphalt oil. Seemingly the difference between interrupting construction operations on a country road and a system of city streets was not properly appreciated.

On the system in question the proceedings were initiated four years ago, but were delayed on account of reconstructing the sewer system. Now the sewer system has been completed. The contract for paving the system was awarded early in April of this year. The work has proceeded to the extent that practically all the curb is in place. Ninety percent of the grading is completed and all the sewer adjustment work is finished. Were the streets left in their present condition they would soon become dangerous, impassable and a menace to health. The subgrade is clay, and with the sewer inlets adjusted to fit the surface of the finished pavement the streets would not be drained but would soon become an unsanitary quagmire. This is special assessment work and to leave it partly completed would undoubtedly introduce legal complications. Yet there is danger that the work will be delayed or its completion interfered with in part.

In this case the specifications are very economical of material. On the 6-in. concrete base is to be placed a 1-in. binder course and a 1½-in. top wearing surface. The amount of pure asphalt in the top and binder courses is only about 5 percent of the 2½-in. asphalt top. The cost of the asphalt is only 1 percent of the cost of the entire improvement. Now, with the situation as described, it is reported that but 60 percent of the work can be finished! Such a rule may be applied in the case of a country road of single length, but cannot be applied in fairness, or to any satisfactory degree, where a complete inter-related system of streets is being improved.

One Extreme Almost as Bad as the Other

"Business as Usual," long since demonstrated its unfitness as the slogan of a great nation at war. Under modern conditions, business cannot be the same in war times as in peace times. That truth is now generally understood and admitted. But there is great danger now that we shall go too far in the opposite direction; that all business will be despised unless it is war business. Such a policy if too long pursued will result fatally to numberless important private business enterprises, not only, but will jeopardize the chief business of the nation—the winning of the war.

The war should be viewed, rationally, as a great industrial enterprise, as the nation's greatest business undertaking, but not as the only necessary and legitimate business of the country. The war in its employment of millions of people, in its concentration of billions of dollars in capital for a specific purpose, in its utilization of machinery and materials for the purposes of production and destruction, is a gigantic industrial enterprise. Like any other industrial enterprise it is dependent for its ultimate success on the proper functioning of general business processes. These thoughts are expressed not through any lack of appreciation of the sacrifices that are being made, and must continue to be made, not from any narrow view of the objects of this most righteous war, but to draw attention to the fact that the war is, after all, not the only business of the country. We trust official Washington can soon devote more thought to this aspect of national affairs.

Being so thoroughly unprepared for war as we were, an economic convulsion had to be endured while the war industry was being organized and getting itself placed among the other industries of the country. There are some signs, however, that the process of adjustment is nearing completion. Perhaps by another year, if the war is still in progress, it will be somewhat more of an industrial side issue and not quite so much the whole business show. This condition has now obtained in Canada for many months. Mars is yet, in a sense, sitting on the Canadian neck, but he is sitting still. That is a relatively desirable condition to which American business can look forward.

Pavement Design and Construction

How to Get the Best Surface on a Concrete Road

By A. H. Hunter, District Engineer, Illinois Department of Public Works and Buildings, 302 Apollo Theater Bldg., Peoria, Ill.

In spite of the excellent riding qualities of pneumatic tires, together with all the experience and skill incorporated in the design of body, springs and wheel base of our automobiles, the automobile public is demanding improvement in the surface conditions of our concrete pavements. I do not feel that this is because previously constructed pavements were so decidedly inferior, but rather that with the coming of long stretches of improved surface, the novelty of riding on concrete diminishes. The traveler traversing longer units than before becomes more weary, and with the accompanying fatigue comes criticism of surface imperfections hitherto unnoticed, said Mr. Hunter, in addressing the American Concrete Institute at Atlantic City, N. J., on June 24.

Any road surface, however durable, can scarcely hope to be ultimately successful for use in our through highways unless this wearing surface presents a minimum of jar and vibration. In a properly mixed concrete, such as is used in concrete road work, we have a plastic material susceptible of being molded into a nearly perfect surface. How closely we are to approach this theoretical plane surface depends upon the care and effort put forth by the workman in finishing. Upon workmanship depends largely the riding quality of surface secured.

The impression is not to be gained, however, that proper design is not essential. It would be utter folly to neglect drainage, crown, or both horizontal and vertical alignment, but fortunately practice is becoming so standardized that most highway engineers recognize these important features in design. It is most infrequent to find a concrete pavement on which poor riding qualities may be attributed to poor engineering.

If we are to avert a repetition of past errors, certain construction features must be carefully watched. These features are to be considered from their significance as outlined in the specifications as well as their application by the layman.

Forms Must Be Rigid

Too often the layman looks upon the side forms as merely a necessary convenience for holding the concrete, thus losing sight of the fact that the proper grade and alignment of these forms are highly essential if a smooth surface is to result. Not infrequently I have visited construction work and found adjacent form boards out of both grade and line. It is probable that in so far as line is concerned, the earth shoulder will later absorb a fair amount of irregularities, but it generally follows that a form setter who does not take enough pride in his work to align the boards properly is equally careless in setting the edge to the proper grade.

In early concrete pavements, wood forms were used exclusively. These, when properly used and well taken care of, have given excellent results. When in the hands of careless workmen they soon warp, spilt, and, when not properly cleaned, cause frequent damage to the edge of the green pavement. When placed to accurate grade and alignment they must be thoroughly staked. Using too few stakes is fatal. If these forms are not rigid, waves, bump and depressions inevitably occur in the completed surface.

Once I heard criticism of the large vibratory finishing machines from the standpoint that they impose a larger load upon side forms than was thought advisable. Personally, I do not take it as a criticism of the machine, but rather of the forms. Make them rigid, and the template, properly used, will cut the surface to the desired shape.

Steel forms are coming into general use. It is probable that specifications in the near future will express a decided preference for them. Many contractors, in an effort to save, purchase too light a weight, with the result that they are soon bent, twisted and unfit for use. In spite of preference for steel forms, they are not to be recommended for short, vertical curves or transverse curves of any character. They are too rigid to adapt themselves to the smooth outline necessary in a properly staked curve.

If we are to improve the surface of our concrete roads appreciably, it becomes necessary for the engineer to see that forms are accurately set to grade and alignment and maintained there. They are the only framework possible in a road. They are as essential as the formwork of a building. They are the guide lines of the pavement.

Templates Need Constant Watching

After the concrete is placed within the forms, it should be struck off with a template having a length slightly greater than the width of the pavement. An excess length of possibly 18 ins. will suffice for average highway work on pavement 15 to 18 ft. in width. This template should be moved by a combined longitudinal and crosswise motion.

Do not make the common error of cutting the arc of the template to the same dimensions as indicated on the cross-section. It should be cut ¼ in. to ⅜ in. deeper than the theoretical crown; otherwise the resulting surface will be flat. This correction should vary to correspond with the width of the pavement as well as general conditions surrounding the job. The amount of water generally employed is a factor, for it is apparent that soft, mushy concrete will flatten out more readily than that containing a lesser amount of water. This template should be shod with a steel edge, using countersunk screws.

Templates may be made from either one or two boards. If two boards are used, they are held apart some distance by small struts. This style insures a more uniform bearing on the forms, but is usually heavy, hard to handle and has a tendency to leave bumps or depressions, as the workmen are reluctant to move it back and restrike the surface.

The writer has seen good results obtained by using a heavy double-edged steel template drawn by a cable, operated by a drum connected with the engine of the mixer. There is a general tendency to supplant man power wherever possible.

In moving the template along the forms, a slight excess of material must be in advance of the cutting edge at all times. Failure to do this will result in depressions or holes. Do not permit the template to ride on stone or gravel on top of side forms. In working on grades even as low as 3 per cent., repeated striking must be done if a smooth surface is to result. The concrete, being plastic and of more or less non-uniform water content, will flow down the grade. This flow is not uniform, but is given to taking the form of alternate humps and depressions, which can only be prevented by repeated and continued striking until initial set takes place. Keeping the amount of water in the mix as low as possible assists materially.

Satisfactory results are obtainable only after pains are taken. The men operating the striker must have an interest in their work or surface defects will occur. Watch the template. Check it up every few days, making sure that it has not warped or gone out of shape.

This matter of crown of pavement was forcefully impressed upon me several years ago, in connection with the construction of my first concrete road. The template used was composed of two striking edges, several inches apart, covered with a plain board on top. At night, after work, it was washed off and placed on the forms behind the mixer. This afforded the night watchman (who, unfortunately for us, was of liberal proportions), or his visitors, a convenient seat. Continued use for this purpose resulted in a reduction in the crown of pavement by approximately ¾ in. This is no large amount, but it is apparent on pavement designed with a minimum of curvature. Frequently, too, a template, properly designed and cut to the required arc, develops a sag, due to its own weight, when placed in position on the forms. In general, templates—home-made devices especially—are not to be trusted. Good surfaces may be obtained, but it is only by exercising care and judgment that satisfaction is secured.

Expansion Joints

In the first concrete road construction expansion joints were used in varying designs. Many otherwise good pavements had their riding qualities much impaired by these poorly placed joints. Unfortunately, highway engineers have not yet agreed among themselves as to what device is best suited to serve the purpose. Until standard practice develops some uniformity, we must expect to have continued experiments, with occasional pieces of pavements unsatisfactory.

Generally speaking, any joint or holding device which does not permit the free use of the template is to be condemned. Not that excellent surfaces cannot be secured, but rather that it necessitates special care for the finisher. The elimination of expansion joints altogether, or possible acceptance of blind joints, will do much to improve the riding qualities of our concrete surface.

Finishing Surfaces as Recently Developed

Naturally enough, concrete pavements were first finished with the same tools as sidewalks or building floors. The public approval of a wood float surface led to the general use of a small wood float, 12 to 18 ins. long, operated by hand. It was possible for the contractor, at small cost, to finish by hand in a most satisfactory manner. It was a tiresome job for the finisher, operating from a cross-plank or bridge. Too frequently the work was intrusted to unskilled men, who probably slighted much of the surface, at the same time probably working holes, depressions or flat places at the more accessible portions of the surface. Many excellent surfaces have been obtained in this manner, but substitution of unskilled labor by the contractor in an effort to effect a small saving, together with the drudgery involved, led to the development of easier and better methods.

Following the hand float came the easier, but unquestionably poorer, experiment of placing a small wood float at the end of a long handle. This being operated from sides of the road, permitted the omission of a bridge. It was applicable to narrow pavements, being used with some success on roads up to 12 ft. in width. In general the surface secured was much inferior to the hand method. The central portions of the pavement were neglected, with the result that too frequent evidence of laitance, dirt or surface defects occurred near the center.

Engineers had recognized the importance of keeping the quantity of water required in the mix to a minimum, but under working conditions a small excess had been permitted, for the reason that concrete of proper consistency was difficult to work. Incidentally, the mixer with spout delivery required an excess of water. Several years ago experimenters in the states of Oregon and Michigan perfected mechanical devices for striking, compacting and finishing concrete, but these, while possessing merit, were heavy, costly and unsuited to operation on short, isolated sections.

It is only recently—not farther back than the construction season of 1916—that two simple operations, developed in different parts of this country, have been brought forward, and, when combined, resulted in radical changes in specifications and methods of finishing. I refer to the combined use of roller and belt in finishing concrete surfaces.

To an engineer of Macon, Ga., we are indebted for promoting the use of a small hand roller, some 8 ins. in diameter and about 6 ft. long. This was operated transversely across the pavement by a handle. The old adage that "necessity is the mother of invention" certainly holds true in the method developed for smoothing concrete surfaces. It is told that a contractor in Michigan, during the summer of 1916, was inconvenienced by a strike which occurred among his gang after considerable concrete had been placed, struck off, but not finished. It seems that in desperation he ripped strips of canvas from his tent, dragged them over the surface in a desperate attempt to place the concrete in a condition satisfactory to the engineer and prevent possible loss. The results were astonishing, so much so that hand finishing was afterwards dispensed with and a canvas belt substituted.

During the construction season of 1917 the engineering organization of the state of Illinois, Department of Public Works and Buildings, Division of Highways, used their influence with contractors and secured their co-operation in experiments sufficient to warrant the department in incorporating this belt-roller finish in the specifications for concrete highways, edition of March, 1918. These specifications, representing the consensus of opinion of the entire engineering organization, are based upon experience gained throughout the state of Illinois, with different aggregate, different workmen and varying general conditions encountered in actual practice.

How to Use the Roller and Belt

The entire operation of finishing is specified to consist of three beltings and two rollings, beginning with a belting and alternating until the final belting. The belts are of a canvas or rubber composition, about 2 ft. longer than the width of the pavement. This belt also should be fairly heavy, but pliable enough to conform to the crown of the pavement. No irregularities should be permitted in the edges, for these will cause ridges or depressions in the plastic surface. In both the first and second belting, the operation should consist of long, transverse strokes combined with a relatively slow, longitudinal movement. After the second rolling, the concrete is to be given a final finish, just previous to the initial set of the concrete. The time interval between placing the concrete to final finish is variable, depending somewhat upon the amount of water in the mix, but largely on weather conditions. In other words, a highly satisfactory surface can be secured by final belting when the film of surface water has just disappeared. In the last operation a light canvas belt about 6 to 8 ins. in width, used with short, transverse strokes, but with a sweeping longitudinal motion, will produce a uniformly gritty surface.

A satisfactory roller may be made with diameter of 8 to 12 ins. and a length of 4 to 6 ft., having a total weight of ¾ lb. to 1 lb .per linear inch of roller. For roads up to 15 ft. in width it may be operated by a long, light handle. Pavement of greater width requires the use of ropes in place of the handle, operated by a man on either side of the pavement. The first belting follows immediately after the strike board, and is in turn followed by the roller. The roller is thus advanced along the length of the road, each unit of surface re-

ceiving four separate treatments. A trip over in the manner described constitutes a rolling.

The surface should again be belted, and, after a lapse of 15 to 20 minutes, again rolled. This time limit must be somewhat variable and left to the option of the resident engineer. Very wet mixing or cool weather encountered may make it desirable to recommend an additional rolling before final belting. In explanation of the foregoing ideas incorporated in specifications, a word of caution in regard to belting is necessary. The first belting is done to smooth up the surface only, remove slight irregularities and facilitate the removal of the surface water in advance of the roller.

In general, belting should be a minimum, for continued working of the surface results in an excess of mortar. Present practice favors the wear coming upon the large aggregate, with only enough mortar present to bond the stones securely and prevent voids.

Possibly the foregoing description of finishing may seem complicated, but in reality the physical labor involved is relatively small—much less than required in the old wooden float method. The cost per unit of surface is materially reduced. Surface imperfections are a minimum. The roller eliminates many bumps, by pushing them into the depressions or placing them parallel to the line of traffic, where they are unnoticed. Each unit of area receives the same amount of attention, and in the end a uniformly gritty surface is obtained, far surpassing in texture, uniformity and riding qualities the original hand methods.

Roads constructed by roller method have shown an apparent reduction in the transverse cracks. Later uncompleted experiments in laboratory tests reveal the fact that with the rolling and removal of water comes an increase in concrete strength.

In mentioning the recent developments of surface finishing it should not be assumed that the roller-belt method represents conditions that cannot be improved upon. For simplicity and low cost of operation it is at present unequaled and its use is to be recommended in the construction of small, widely separated sections of work. It appears probable that future developments in concrete pavements will have largely in mind the proportioning of aggregate so as to produce the greatest possible strength. In connection there will come equipment which by rolling, tamping or otherwise will increase the density and strength, at the same time securing all the advantages of a roller-belt finish.

Maintaining Sand-Clay Roads in North Carolina

Everybody who has driven over an earth road knows that some well-drained sections are likely to be much better than others equally well-drained, but the reason for this is rarely understood. In most cases the good road is due to the fact that the sand and clay forming the surface are mixed in proportions which will give the most dense combination. There is just enough clay to bind the sand together. Hundreds of miles of good roads are now being built, duplicating artificial roads. The mixing of the sand and clay is carried on by well-developed methods and gives a good road for light traffic.

There have been many miles of these roads built in North Carolina and during the last winter a good many of them went to pieces. There was a tendency to attribute this to a failure of the type of construction, but an investigation made by Dr. Joseph Hyde Pratt, Secretary of the North Carolina Highway Commission, indicates that the trouble was due to the imperfect maintenance of the roads, which were so weak in consequence that the severe conditions of the winter inevitably damaged them, as they would have damaged any other type of construction which had been neglected until it was ready to go to pieces. Dr. Pratt insists that a sand-clay road can be maintained in good condition for any traffic for which the type is fitted, by an intelligent use of the road drag. The purpose of dragging such a road is not to bring new material up on it but to smooth out the ruts and holes by shaving material from the high places into them and rubbing it into a dense condition there. If this is done after every heavy rain a well-built sand-clay road can generally be maintained in excellent condition. It is important, however, not to scrape material from the side ditches over the roadway, because this material is not fitted for filling depressions. It usually has unsatisfactory proportions of sand and clay and often contains so much organic matter that it is incapable of becoming consolidated into a hard surface.

Where a road has become badly rutted and filled with holes, so that dragging will not remedy the neglected surface conditions, Dr. Pratt recommends reshaping the road with a road machine and then dragging it thoroughly after the first rain. If it is necessary to add new material on the surface, great care should be taken that it contains the sand and clay in the right proportions for the work, and, if possible, is the same material used in the original construction of the highway in general. Dr. Pratt believes that the sand-clay road, if it has been surfaced with the right kind of material, has been constructed properly and maintained efficiently, will prove a good highway, even under as severe conditions as those existing in North Carolina last winter. But this type of construction must be well maintained, and unfortunately there has been a lack of good maintenance throughout the state, particularly noticeable where the traffic has considerably increased since the roads were built.

Procedure in the Construction and Maintenance of Kentucky Rock Asphalt Roads

By S. O. Le Sueur, Paul Jones Bldg., Louisville, Ky.

One of the most serious problems that confronted the government at the beginning of the war was that of transportation; the problem is still serious. Various government committees have been advocating the use of the highways by motor trucks, with the object in view of relieving the railroad congestion. While good progress has been made along this line, it is far from satisfactory, and the reason for this is the condition of the highways. Motor trucks cannot operate to best advantage on roads that have even one short "weak link," consequently the improvement of the highways is essential today. Macadam, or cheap roads of similar construction, will not stand up under the heavy motor traffic to which they are being subjected. Roads of a more permanent nature must be constructed, or old roads must be surfaced with a hard type of material. Expensive types of construction are prohibitive in some counties and small cities on account of the first cost.

A permanent road of low first and upkeep cost can be laid with Kentucky rock asphalt. It is laid cold upon a base prepared as for macadam construction, with the exception that the screening course on this base is left off. The object in leaving off the screening course is to enable the material to work down in the voids and create a bond. This makes the road waterproof.

In resurfacing old construction the road should be scarified and only a sufficient amount of new stone added to give an anchorage. The stone should be from 2 to 3 ins. in size.

One ton of this rock asphalt will cover 18 sq. yds. of roadway in small towns or on county roads. For city streets and roads that are subjected to heavy traffic one ton to each 15 sq. yds. should be used. The material should be spread over the base, raked, and rolled cold. The road should be rolled once daily for three consecutive days, and is then ready for traffic. A roller of at least 10 tons in weight should be used, or one that has as much as 200 lbs. compression per lineal inch in

width. The completed road strongly resembles sheet asphalt, except that it is darker in color. There is no glare reflected from the surface.

The maintenance feature of roads of this type is one that appeals to road builders, since any defective place can be repaired in a few moments without interruption to traffic. This can be done by inexperienced men. The defective place is cut out a little, fresh material added, tamped with a hand tamper, and within two or three days it will be impossible to locate the spot where the repair was made. One man, with a suitable vehicle in which to carry a small quantity of the material, a pick, shovel and hand tamper, can maintain many miles of road at very little cost.

Kentucky rock asphalt has been used quite extensively in most of the central states. Kentucky has many miles of this

VIEWS OF KENTUCKY ROCK ASPHALT ROADS.

Base Course; Note Absence of Screenings—Asphalt Raked Over Base Course and Ready for Cold Rolling—The Completed Road in Service.

construction. Fayette county, in that state, has some 12 miles surfaced with it, and the Dixie Highway leading south from Louisville has a section of 7 miles in length that was surfaced with it over a period of 6 years. This road probably carries the heaviest volume of traffic in the state. At present, and for the past several months, it has been subjected to abnormal traffic, since the United States artillery range, located at West Point, Ky., uses it exclusively for all traffic between that point and Louisville. The road shows no evidence whatever of wear, although some of it has been laid for over six years. Approximately 4,000 vehicles per day use it.

This road and the roads in Fayette county, above mentioned, are considered by many road authorities as among the best roads in Kentucky.

The Action of Water on the Road Subgrade and Its Relation to Road Drainage

By J. L. Harrison, Highway Engineer, Road Management Division, Office of Public Roads and Rural Engineering, Washington, D. C.

The simple rising of the water table often causes highway troubles. "Keep the subgrade dry" is an old-time admonition, which was frankly based on the assumption that a good highway surface would "shed water like a roof." The dry subgrade is as much to be desired as ever, but no matter how well the "roof" acts, the subgrade will not remain dry unless water can be kept from rising into it from below.

Herein lies much of the trouble which highway engineers experience in preserving smooth pavement surfaces during the spring months. At this season more moisture is supplied than evaporates or is carried off in the ground-water drifts. As a result the water table often rises to such an extent that in low areas lakes are formed, and if a highway chances to be built over an area where this rise in the water table has brought the pavement foundation into the region of complete saturation, a marked lessening of the supporting power of the foundation necessarily results.

Limitations of Tile Drainage

Tile drainage is the usually accepted remedy for this condition of affairs, but tile drains have, very generally, proved to be of less usefulness than had been expected. One reason for this is that the water table does not have to rise into the foundation of a road to make it the source of trouble. All that is necessary is that it rise enough so that capillary attraction can keep the foundation wet. Just how near to the surface this may be has not yet been determined, but as extensive studies of the effect of capillary attraction in raising the water needed to support plant life show that capillary attraction will raise water through some soils as much as 6 ft. or more, the problem of escaping the results of capillary attraction at once appears to be a serious one. And herein lies the trouble with many of the systems of tile drainage which have been installed.

Tile drains lower the water table—that is, the level of complete saturation—but they do not affect the action of capillary attraction. As such drains are seldom placed more than 3 or 4 ft. below the surface, they do not at all prevent the wetting of the subgrade, for, in almost all soils, capillary attraction will raise enough water to keep a subgrade wet at even greater distances than this above the water table. This difficulty with tile drainage systems is entirely aside from positive errors of installatien, such as the use of tiles of too short a diameter, the use of tiles without bells, the use of gradients which are too light, etc., and is an elemental difficulty which, in our present knowledge of this subject, must be admitted as existing, but which is, as yet, unsolved.

Capillary Attraction

As illustrating to what an extent capillary attraction may affect the moisture content in the soil under a pavement, it will be interesting to many to know that one sample of soil taken just below a pavement in the business section of Washington, D. C., an asphalt pavement on a heavy concrete base, showed 12.23 per cent. of moisture by weight, which is approximately 32 per cent. by volume. The cut which had been made in the street where this sample was taken was about 10 ft. deep, but had not yet reached a level at which free water collected in the trench. In view of the nature of this pavement and of the fact that all of the ground for considerable distances in all directions from the point where this sample was taken is covered either by buildings or by sidewalks and pavements, it must be assumed that whatever water was found in the soil

under it had come to that level by being raised from below.

Here is a case, therefore, where capillary attraction had raised water enough practically to saturate a pavement foundation which is at least 10 ft. above the water table. In this particular case the soil under the pavement is clay. In its nearly saturated condition this clay is as plastic as good putty. Just what loads it will support has not been determined, but that if the water content in it could be reduced, its carrying capacity would be materially increased can hardly be doubted. This case has been cited because it shows very clearly the range over which capillary attraction may act, and the amount of moisture which may be involved. It is not, however, an isolated case, for the writer has found a good many pavement footings which contained even more moisture than this.

Heavy Clay Soils

As has been pointed out, tile drainage does not solve this problem. Tile drainage will remove any water subject to the action of gravity, but in heavy clay soils the per cent. of water so affected is so small that the actual level of complete saturation—the water table—is often hard to determine. The converse of this fact is that in heavy soils the percentage of water which may be raised by capillary attraction is very high and the distance through which the water may be raised is correspondingly great. Where the soil is subject to the direct action of the sun and the wind, the moisture raised by capillary attraction is evaporated, and so the large amount raised each season and dissipated through evaporation is unnoticed, but where the surface is covered by an impervious layer, as by a hard pavement or even by a board, the constantly rising moisture fails to escape as it does in the open country.

No Dry Subgrade

In fact, examinations of the water content in the soil under numerous hard pavements shows that even when the soil in the surrounding fields is so dry that plant life has withered, 30 to 40 per cent. (by volume) of water may be found in the soil immediately under the pavement. This would seem to make it clear that a pavement may so shield the subgrade that a high water content is preserved even during the dryer months, so high a moisture content, in fact, that it would seem fair to conclude that the much-talked-of "dry subgrade" is, for ordinarily humid regions, purely a myth.

Why "Dry" Subgrades Freeze

The significance of this condition of the subgrades composed of heavy material, even at elevations of 10 ft. or more above underlying water tables, is far-reaching. In the first place, it suggests a lower carrying capacity for subgrades than is usually assumed. But more in line with the subject matter of this discussion, it suggests a very cogent reason why so-called "well-drained, dry" subgrades freeze during cold weather, namely, that they are neither "well-drained" nor "dry." It may be, in fact it often is, true that they are "drained" in the approved fashion, but that they are "dry" is to be doubted, both from the fact that repeated examinations show that the soil under the pavements in the eastern half of the United States are almost never "dry," no matter how well they have been "drained," and beacuse, had they been dry, they most certainly could not have frozen.

Cracking of Pavements

As affecting hard surface roads, another matter of drainage deserves consideration, namely, the relation of water in the subgrade to the cracking of these pavements. It has been shown that capillary attraction supplies so much moisture that the soils under hard surface pavements are seldom dry. During cold weather the moisture in the soil freezes, solidifying the ground into a block often a number of feet thick. This process proceeds under a pavement just as it does in other places. However, this freezing causes little or no trouble. In fact, it is practically the uniform statement of engineers familiar with this matter that hard pavements go through the early winter without trouble. This is due to the fact that the freezing proceeds from the top downward and that the underlying soft earth takes up all of the expansion caused by the freezing.

As the winter proceeds, the surface of the ground now being a layer of ice-bound soil, winter thaws occur which melt the snow that is on the ground, and perhaps also a few inches of the soil. When this occurs a wholly different problem in road drainage is presented, for the water which is taken up by the melted soil on the surface cannot percolate into the lower strata because of the intervening layer of frozen ground. Under these conditions it may, and, in fact, often does, happen that the top of the ground becomes completely saturated.

The pavement, of course, protects the subgrade from the direct admission of water at such times as this, but this is by no means an adequate protection, not to mention a complete protection, for the complete saturation of the surface of the ground really amounts to nothing less than raising the water table to this level. Under such conditions, if the subgrade is level with or cut below the surrounding country, there is a distinct tendency for the plane of complete saturation to work its way under a pavement just as it does, for instance, under a house when the cellar fills with water from below.

More or less of the water in the soil at such times is in excess of what could be retained there by capillary attraction, and so is subject to comparatively rapid influence by the forces of gravity. Hence the distinct tendency of this surplus water to move rapidly into such places as the soil in a pavement footing, in response to the general principle that water will seek a level.

Rapidity of Capillary Action

Even when the pavement rests on an embankment it is subject to immediate effect under such conditions as this. As stated before, the saturation of the surface of the ground, under conditions which prevent the percolation of surface water into the lower strata, is, for all practical purposes, equivalent to the elevation of the water table to the level of the surface of the ground. Repeated experiments made by those who are investigating the movement of soil moisture, as affecting plant life, have shown that the rate of movement by capillary attraction may be very high where the lift is short.

Under the conditions here assumed, therefore—that is, where comparatively low embankments have been constructed over flat lands—the saturation of the top soil on the flat land will produce a condition almost exactly equivalent to that which would be produced if this land were actually flooded with water, and the effect on all of the subgrade which is thawed out, even if only a few inches of the surface and a few inches under the pavement have been thawed out, will, for all practical purposes, be the same. This is because capillary attraction will raise water even in a comparatively thin layer of thawed-out soil covering the surface of an embankment, just as water is raised by a wick, and will distribute it horizontally through the shoulders and under the pavement within the space of a very few days, or, if the shoulders and slopes are already wet, even within a few hours.

Of course, the rapidity with which a subgrade is wetted in this way depends both on its height and on the material of which it is composed, but as the subgrades usually used in highway construction are comparatively low, they are almost always within the range of capillary action.

In passing it might be noted that the major reason for objecting to free running water in ditches and to standing water on or near the right of way is based on this same general fact, namely, that capillary attraction will very promptly bring this water into the subgrade, where it acts to lessen the supporting power of the ground on which the pavement rests.

Spring "Break-Ups"

The result of the condition here discussed is weak subgrades. Highway engineers are thoroughly familiar with the

phenomenon known as the "spring break-up," especially as affecting gravel and macadam pavements. These "break-ups" are caused by the excessive softening of the subgrades under these pavements, and the softening is, in turn, caused by the excessive water brought into the subgrade by capillary attraction when the normal subdrainage of the soil is blocked by frozen soil underlying the surface of the ground, and a surplus of water consequently collects on the surface. No systems of drainage, as at present designed and installed, will care for this condition, for they are all likely to become clogged with ice during cold weather, or else they are so far below the surface that they are wholly cut off by the frozen block of ice-bound soil which overlies them.

As for hard-surface pavements, much breaking is, no doubt, due to positive overload during periods when these conditions have rendered the subgrades so wet as to be abnormally plastic, and consequently of low supporting power. The major part of the breaking of these pavements is, however, due to refreezing after the conditions above discussed have practically saturated any thawed-out portion of the subgrade. When the refreeze comes, conditions are different from those which prevailed at the time of the year when the subgrade was first frozen in this one particular, namely, that now the water which freezes is contained in a space between the pavement and the still unthawed portion of the originally frozen ground mass.

Freezing Under Pavements

It is not necessary to go into a long discussion of the phenomena of freezing. Suffice it to say that in freezing, the water caught between the pavement and the frozen ground exerts a tremendous positive force which is ample not only to crack heavy pavements, but to lift them considerably out of line. Moreover, the force developed in freezing is not usually relieved by a uniform movement in the overlying slab. If it was so relieved, all of a pavement block would be moved a small fraction of an inch and no great harm would be done. This does sometimes happen, but if it chances that conditions in the pavement initiate failure at some one point, all of the pressure is relieved at this point, in which case the distortion at this point may be considerable.

This is very similar to the process by which a boiler explodes. As long as the boiler holds, the pressure is equal on all parts of the interior. But when the stay bolts fail, the front plate may be blown clear out of the building. This, by the way, explains why one corner, or one edge, or one end, etc., of a pavement block may be raised a number of inches when the total expansion due to the freezing of a good many feet of water would not equal this amount. Of course, relief has occurred at a point, rather than by a general elevation of the block, and the excessive distortion is the result.

Use of Broken Stone or Telford Base

For the relief of this general condition the writer recommends the use of broken stone or telford base, unfilled with fine material and consequently containing voids so large that capillary action will not fill them with water. These footings should be deep enough to extend below the reach of late winter and early spring thaws and should be so drained to the ditches that no ordinary percolation, no matter from whatever source, can fill them with water. Such a system will be expensive, but it can hardly be doubted that it will be valuable enough in protecting pavements during spring weather to more than justify the necessary expense of its installation.

What Loads Can Subgrades Carry?

In closing, it is desired to point out that the careful consideration of the actual condition of pavement subgrades is becoming of more and more importance. Loadings are increasing rapidly and the highway engineer must either provide for these heavier loadings or definitely prove that they are not economically feasible. To do either he must be able to tell pretty definitely what his subgrades can be depended on to carry, and in order to arrive at this fact he must know how his footings are going to be affected both by the water which falls on the right of way and by that which comes to it in other ways.

The notes here presented outline the problem. They do not solve it. However, they are presented with the feeling that the longest step toward the solution of a problem has been taken when the problem itself is clearly stated. The solution will come in time, but pending the solution it will be well to act on the assumption that the greatest problems in land drainage lie under the ground and are often most a factor where their presence has at first been least suspected.

Experiences in Force Account Paving in the City of St. Paul, Minn.

By Oscar Claussen, Chief Engineer, Department of Public Works, St. Paul, Minn.

The most important municipal engineering work that is carried on by a city corporation is that of paving. Certainly the average large town in this country spends more money for pavements than it does for any other engineering work, and the city of St. Paul is no exception to this statement, as the following comparison will show:

Period		Approximate per cent of total
Expended for sewers during last 6 yrs.....(1912-1917)	$1,875,000	35%
Expended for grading during last 6 yrs.....(1912-1917)	624,000	12%
Expended for sidewalks during last 6 yrs.....(1912-1917)	243,000	4%
Expended for curbing during last 6 yrs.....(1912-1917)	120,000	2%
Expended for pavements during last 6 yrs.....(1912-1917)	2,480,000	47%
	$5,342,000	100%

With such figures at our disposal, the incentive and attempt to save money on construction of pavements would seem to be the imperative duty of the Department of Public Works, said Mr. Claussen, in addressing the St. Paul Civil Engineers' Society on May 20.

Local Conditions

When city force account paving was done for the first time in 1912 there was a demand for it by the public. The idea had impressed itself on the public that paving by contractors in previous years had been done poorly and that large profits were exacted. Barring some individual jobs, this idea was an erroneous one. As a general rule, pavements laid by contractors were well and substantially built, and in accordance with specifications, and the profits did not average more than 10 to 15 percent, in my judgment. Such profits are not exorbitant and not more than contractors should be entitled to. I believe this is generally conceded all over the United States. This 10 to 15 percent, applied to cost of pavements laid in St. Paul during the last six years, amounts to from $248,000 to $372,000, or enough money to maintain the Department of Public Works for the period of six years.

Realizing this condition of affairs in 1912, the opportunity of doing force account paving was grasped with enthusiasm, but with a mind fearful of what the practical results might be. Beginning with three paving jobs in 1912, the department has executed as high as 15 jobs in one year. Out of a total of 59 paving jobs executed during the last six years, 32 were done in competition with the lowest bids received from contractors and in each and every one of these 32 the actual cost of pave-

ment was less than contractors' lowest price bid. While in some cases the percentage of saving was very small, others were done where the contractors' lowest bid was 15 to 25 per cent higher than the actual cost of the pavement laid, the average of all jobs laid in competition being approximately 10 percent.

Importance of Cost Estimate

One of the most important operations involved in connection with force account pavement is the making and securing, as far as it is possible to do, of accurate estimates of cost, as these, of course, are the determining element in deciding, after bids are received, whether to let the work by contract or proceed to do it by force account.

Contrary to the belief of at least a large portion of the public, it is not possible for any engineer to figure or predetermine the exact cost of any piece of engineering work. Such an engineer has not yet been discovered and never will be. The engineer never gives the cost of the work; all he does and can do is to give an estimate of the cost, his estimate of cost being more or less close to the actual cost, in accordance with the experience, thorough knowledge and judgment he has about the particular kind and nature of the work to be performed. If the actual cost gets within 5 percent of the estimated cost, any engineer will consider it a lucky performance. If it were possible generally to predetermine the exact cost of engineering work, or even within 5 percent of the actual cost, contract work would be done only in exceptional cases. However, on some work it is much easier to make a fairly close estimate of cost than on other work, as will be shown.

The two items of an estimate of cost are labor and material. The quantity of or amount of material for a piece of engineering work is generally quite definitely called for and prescribed in plans and specifications, and therefore the cost of it can be quite accurately ascertained, but the labor, the second item of a cost estimate, cannot be readily predetermined and is very difficult to figure accurately. Therefore, on all engineering work where the percentage of cost of material of the total cost is large, and the percentage of labor is small, it is quite possible to make a fairly accurate estimate of cost, and, on the other hand, where the percentage of labor is large, and the percentage of material small, it is much more difficult to furnish an estimate of cost approximating the actual cost.

Material Cost, Largest Item, May Be Accurately Estimated

Now, on paving work, the cost of the material amounts to from 70 to 80 percent of the total cost, while the labor cost amounts only to from 20 to 30 percent of the total cost. Particularly is this true with block pavements, such as brick, sandstone or creosote block, therefore it is possible to arrive at fairly close actual cost figures of pavement work, both the quantity of material and the price of it being definitely known and constituting 80 percent of the total cost, while the amount of labor is not definitely known, but constituting only 20 per cent of the cost. For example, suppose the cost of finished pavement is estimated at $3 per square yard. Of this amount, say 80 percent, or $2.40, constitutes the cost of material, and is, within very narrow limits, definitely known, while 20 per cent, or 60c per square yard of finished pavement, constitutes the cost of labor, not definitely known and liable to vary greatly. Now, after the pavement is finished, we find that the labor item has been 50 percent more, or 90c per square yard, and the actual cost of pavement per square yard is $3.30 instead of $3; that is, while the item of labor was increased 50 percent over the estimate, the cost of completed pavement was increased only 10 percent. The above explanations are made for the purpose of showing that it is in fact possible for the engineer, with proper experience, to give an estimated cost of a paving job that approximates closely the actual cost. The engineer is in a position to know, within reasonable limits, what a pavement will cost, and therefore, in a given case, can figure in competition with a contractor whether he can do the work and save money over the contractor's figures or not. In other words, the risk and chances of the estimated cost being largely exceeded are very small. Therefore, because all elements entering into the cost of the work are fairly well known, and we know, within reasonable limits, what the actual cost of a pavement will be, barring accidents or mistakes, which may and do happen once in a while, we are in favor of force account work on pavement.

Labor Big and Uncertain Item on Sewer and Grading Costs

This reasoning does not hold good with sewer or grading work, which is the work next in importance and amount, as has been previously shown. For instance, in sewer work, the labor cost, which is the element of uncertainty, amounts to from 60 to 70 percent of the total cost for sewers up to 20-in. diameter, and constitutes about 40 percent for sewers as large as 4 or 5 ft. in diameter. If we should find, on a sewer job estimated at $20,000 ($13,000 for labor and $7,000 for material), that the labor item overran our estimate 50 percent, the sewer would cost $26,500, or about 33 percent more than estimated. With that happening we would be left in a fine predicament to explain the assessment figures to interested property holders.

An additional element of uncertainty as to cost of sewer work is the unknown nature of the ground and the possible presence of water, quicksand, boulders or rock; therefore, sewer work, whether done by force account or contract, is a mere gamble as to cost. Contractors largely guess at the cost, and sometimes guess right and frequently wrong.

With grading work similar conditions prevail; while the labor item on grading work generally constitutes 100 percent of the cost, and therefore is uncertain, the nature of the ground is not quite as uncertain as prevails with sewer work.

Therefore, because the cost of sewer and grading work cannot be ascertained and predetermined within reasonable limits, and because, in other words, the element of risk is too great, the department is not in favor of doing sewer and grading work by force account.

Where Best Men Set the Pace

Other reasons for favoring force account paving are as follows: It has already been stated that the main element of uncertainty in the cost of engineering work is the labor cost. Where the nature of the work is such that it will admit of employing laborers in squads under a competent foreman, all laborers working together as a unit to accomplish a cohesive piece of work, and where it is impossible for the individual laborer to shirk his allotted quota, where each man must do as much work as the best in the gang, and where the best man necessarily sets the pace, work can be done more cheaply and more can be accomplished than on such work where each individual does some work different from the others, where he does some separate job by himself, where one man's work does not directly affect the other man's work; in other words, where there is a chance for an individual to loaf on the job. On paving work the men largely work in squads. To begin with, there is the grading crew, then comes the concrete crew, and then the block-laying crew or the asphalt crew on asphalt work. Each man in his crew must work like a link in a chain, all doing equal amounts of work, and if one link breaks the entire operating mechanism is thrown out of gear. Laborers appreciate that this cannot be and is not tolerated, and, in fact, do not ask for it. It also necessarily means, in the nature of things, that strong, husky men must be employed, men that can accomplish a day's work. In this manner very efficient work is accomplished on paving work operations in contrast to a good many other municipal operations.

Claims Better Work Secured

Another reason why the Department of Public Works favors force account paving is that, on the whole, better work can be secured. It is not because contractors attempt delib-

erately to skimp the work. It is not intended to make this charge. However, contractors do rely and have a right to rely on the city's inspectors to watch the work and see that it is properly done. For the securing of good workmanship, the city must necessarily rely on various inspectors, more or less competent. Such men as the city can secure have at best only a limited knowledge of paving requirements; they are men whose technical qualifications are not of a high degree with reference to construction of pavements and whose salaries are low and whose employment is of a temporary and shifting nature. These inspectors cannot be employed throughout the year, and their services are needed only for a few months through the summer season, and each season a large number of new inspectors are employed. Men of special knowledge and experience, who can command and get adequate salaries, cannot, except in rare cases, be secured by the city under these conditions.

Costs Closely Kept

Another element in favor of force account work is the fact that the department keeps a very close cost record of all the labor operations carried on, as well as of the constantly varying costs of material, and in this manner valuable cost data are constantly at our disposal, allowing us to keep a close check on any bids submitted by contractors with reference to the profit figured in the job. Thus the contractor is always compelled to figure his work with a small margin of profit and submit a low bid. In this way, even if the work is done by contract, it is done at a lower figure than by competition with force account eliminated.

Claims Lower Costs

The primary reason, however, for the Department of Public Works favoring force account paving is the belief that a large saving in the cost of the work can be accomplished. The department does not, by any means, maintain that all pavements should be laid by force account. Each individual paving job should be considered by itself. At times the city may not have the proper organization at its disposal, at times it may not have the proper equipment readily available, or it may have more work to do for periods than can be conveniently handled, also the contractor may have made a mistake on bidding, for some reason or another, a lower figure than the department has estimated the cost of the work. At times the contractor's judgment as to the cost of the work may vary considerably from that of the engineer, and where this judgment dictates a figure considerably lower than the engineer's figure, ordinary prudence should demand that the work be performed by the contractor.

The Department of Public Works has never claimed that in all cases paving should be done by force account; it has never claimed that in all cases the work could be done cheaper by force account. Being just mere human beings, it is certain that on one or the other case the engineer's judgment will be at fault and the cost of a paving job will be more than the contractor's lowest bid price. Particularly is this true at the present time, when prices on material are varying from week to week and the element of labor expense is almost impossible to take into account adequately. To date the Department of Public Works has executed 32 paving jobs in competition with contractors' lowest bid price, and in each and every case a saving has accrued, the total saving on these 32 jobs amounting to $73,000, exclusive of depreciation charges. During the years 1913 and 1914 all paving work was ordered done by force account by the council without receiving bids from the contractors, and therefore on the 26 jobs executed in 1913 and 1914 by force account a comparison of contractors' bids cannot be made. However, the work done in 1914 comprised the largest program in paving ever carried out in this city in any one year, the cost amounting to $760,000, equal to 23½ miles on the basis of a 27-ft. roadway.

Conclusion

I would like to have it appreciated that what I have said about force account paving is not intended for propaganda; it is merely intended as an attempt to clarify the situation and bring out facts and arguments, from which, of course, engineers will draw their own conclusions. The Department of Public Works has attempted force account paving and advocated it in most cases because we believe it accrues and has accrued to the benefit of the public. Carrying on force account means to the department the expenditure of a large amount of energy over that required to carry on contract paving; also it means a great deal of worry. We have always felt that if we could not beat the lowest contractor's bid price, we would be subjected to a considerable amount of criticism by the public. We have never felt that it was possible to go along and do job after job against the lowest contractor's bid and beat him to it. It should be clear to every one that such a task is absolutely impossible, and if it did happen, would be a miracle. It is, of course, impossible to prove absolutely that force account is cheaper than contract work. If it could be done, there would be no controversy whatever about the proposition.

All that can be done is to present circumstantial evidence from data, arguments, past experience and actual results. In my judgment, contract paving, as a fixed policy, cannot be justified unless it is admitted that contractors will do work without a profit, and it would not be consistent or reasonable to assume that.

WATER WORKS DESIGN AND CONSTRUCTION

Design and Construction of Water and Sewerage Works at the Hog Island Shipyard

By W. H. Blood, Jr., 1305 Medical Arts Bldg., Philadelphia, Pa.

The construction of the Hog Island shipyard is one of the greatest engineering feats of the world. On September 13, 1917, Hog Island consisted of about 900 acres of desert land; there were no buildings on it, not a stick of timber, and not even a passable road. Today it is a mammoth shipyard, nearly completed, and practically in full operation. In fact, it is the largest shipyard in the world, and it contains one-quarter as many shipways as all of the shipyards in Great Britain combined. It is an industrial city of over 26,000 people, and as such has all the modern conveniences of the most up-to-date city of that size.

The American International Shipbuilding Corporation is responsible for this transformation, and in bringing it about has utilized the financial resources of the American International Corporation, the construction organization of Stone & Webster and the shipbuilding talent of the New York Shipbuilding Corporation.

The work of construction began in real earnest on September 20, and on June 20, 1918, the yard was 90 per cent. completed and had 30 steel ships under construction. The total

expenditures here under the existing contracts will practically equal those at Panama, but while the construction of Panama continued for 12 years, the work at Hog Island is to be completed in about 24 months.

Difficulties Surmounted

Work at Hog Island has gone on continuously through a winter of unprecedented severity, with labor conditions the worst in history, and in the face of inadequate transportation and housing facilities. The whole idea of the work here has been "speed," and all expenditures have been justified on this score. This has been a war measure and has been just as important as digging the front line trenches, where the whole job has been to get the work done quickly.

On a commercial basis, however, the charter value of the 180 ships which are being built here is $460,000 a day, or approximately $14,000,000 per month, so that it is evident that any expenditure up to $460,000 which would save a single day's time in the delivery of the ships would have been justified, to say nothing as to the value of the ships as a means of ending the war.

The readers of MUNICIPAL AND COUNTY ENGINEERING will be interested to know of some of the utilities which were constructed during the winter months, when the ground was frozen 3 to 5 ft. in depth, and the following paragraphs describe the water and sewerage systems which have been installed in this new industrial city.

The Domestic Water System

This system is designed to supply water for domestic purposes, for locomotives and heating plants, as well as to furnish fire protection in the barrack quarters, which have no high-pressure lines.

The domestic pumping station contains four motor-driven centrifugal pumps and two vacuum pumps used to prime the other pumps. Two of the centrifugal pumps, known as low-service pumps, are operated by 20-h.p. motors, and are used to pump the raw water through the 16-in. suction line from the Delaware river. The other two are used to pump the filtered water into the mains.

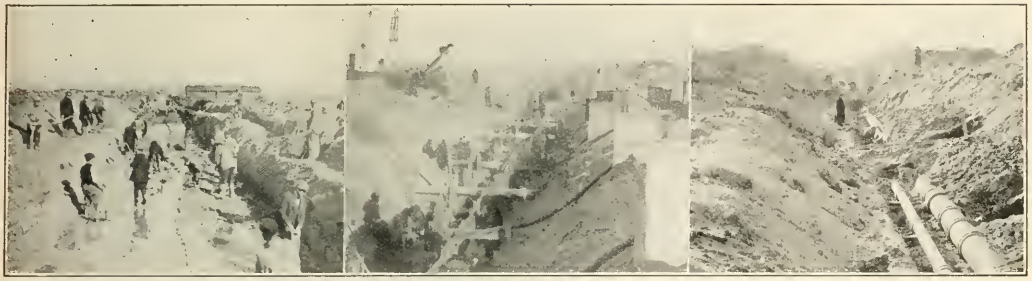
Water Purification Plant

The suction line at the river end has strainers to keep foreign matter from entering this line and causing injury to the pumps. These pumps are each capable of delivering 1,000 gals. per minute. Before the water has passed the low-service pumps, a solution of alum is put in the suction line. It then enters the subsidence tanks and is stored long enough to allow nearly all the suspended matter to settle to the bottom. There are four of these tanks, each 16 ft. high and 33 ft. in diameter. The water flows from these into the four units of the gravity filters, after which it enters the storage reservoir below the filters. On its way to the filters the first application of chlorine is made. The storage reservoir has a capacity of 150,000 gals. Each one of the filter units is capable of filtering 500,000 gals. per day.

The water in the reservoir is pumped directly into the distributing mains by the second pair of pumps mentioned. These pumps are driven by 75-h.p. motors, each having a capacity of 1,000 gals. per minute. Chlorine is applied to the filtered water as it enters the suction of these pumps. This has the effect of completely sterilizing the water.

The Distribution System

The distributing mains are laid on a gridiron system so as to obviate dead ends, and also to give uninterrupted service to



CONSTRUCTION OF MAIN SEWER AND WATER TRENCH, HOG ISLAND, PA.
Left to Right: Main Trench, East—Main Trench East From Wharf Road—Main Trench, West.

USING THE LIVE STEAM METHOD OF THAWING FROZEN GROUND BEFORE EXCAVATING FOR HOG ISLAND WATER AND SEWER LINES.

the majority of the lines in the case of a break in any one of them. Valves are also well distributed at intersections and along long lines so that it is possible to isolate short portions for repair and other purposes.

A 150,000-gal. steel tank and tower 125 ft. high, located near the center of the yard, also acts as an additional reservoir. An altitude valve at the base of this tank so works that it maintains the water in the tank at a fixed elevation when the pumps are working, but it permits it to feed into the distributing system when the pumps are closed down or when the rate of consumption is greater than the amount being supplied by the pumps.

Besides this steel tank there are four wooden tanks, with capacities ranging from 20,000 gals. to 60,000 gals., situated in various parts of the island. They are connected to standpipes for supplying locomotives with water. Altitude valves keep the water in the tanks at a fixed elevation.

As previously stated, this system also supplies fire protection for the barracks section. Hydrants are connected to the mains at frequent intervals throughout this district.

In case of a breakdown in the high-pressure and auxiliary pumping station it is possible to have the low-service pumps deliver water directly into the high-pressure lines.

in the high-pressure station. Both the high-pressure station and the auxiliary station serve the same lines. This system is also laid on the gridiron plan and is supplied with a generous number of valves.

Hydrants

Fire hydrants are located at frequent intervals along all the streets throughout the shop district. As an additional precaution against fire on the shipways, there are two fire hydrants for each shipway on the Front street line, as well as additional fire lines with frequent hose connections on alternate shipway piers.

As stated in the description of the domestic water system, the low-service pumps can be made to pump into the high-pressure lines in case of a break in either the high-pressure or auxiliary pumping stations.

Hydrants with steamer connections are located at the end of each pier, so that additional water can be furnished by fire boats pumping into the lines through these connections. Water for the compressor houses is also furnished through this system.

The main lines range in diameter from 6-in. to 20-in.; 4-in. lines are used for connections to hydrants and for supplies to the compressor houses.

VIEWS OF THE DOMESTIC WATER FILTRATION PLANT AT HOG ISLAND, PA.
Left: Foundations for Filter Tanks, East End. Right: View of Completed Plant.

The following figures will give an idea of the amount of pipe laid on this system:

Suction line, 16-in. cast iron pipe, 450 ft.; other cast iron pipe lines as follows: 12-in., 1,400 ft.; 10-in., 3,900 ft.; 8-in., 14,650 ft.; 6-in., 19,870 ft.; and 4-in., 24,950 ft. Galvanized pipe: 3-in., 3,500 ft.; 2½-in., 1,600 ft.; 2-in., 22,000 ft.; ½-in. and 1½-in. service connections, 25,000 ft. Total length of metal pipe lines, 117,720 ft. There is also a 3,200-ft. 6-in. wooden pipe line. The total length of domestic water pipe lines is 22.9 miles. There are 28 4-in. hydrants on this system.

High-Pressure Fire Protection System

This system supplies water for fire protection for all of Hog Island, with the exception of the barrack quarters; for latrines along the ways, for the compressor houses and for testing ships, as well as sprinkler systems in various buildings.

The high-pressure pumping station contains 6 125-h.p. motor-driven centrifugal pumps, each capable of pumping 1,900 gals. per minute against a head of 148 ft., or they can be worked in series and have three units with a capacity of 1,900 g.p.m. each against a head of 296 ft.

The suction is a 24-in. cast iron pipe line 740 ft. long. Its lower end is attached to a double strainer to keep material from getting into and injuring the pump.

The auxiliary pumping station contains 4 125-h.p. motor-driven centrifugal pumps, with similar characteristics to those

All of the buildings which are heated throughout the yard have sprinkler systems in them. These buildings are mostly in the administrative group.

The following is the approximate length of the various sizes: 24-in. cast iron suction line, 750 ft.; other cast iron lines: 20-in., 575 ft.; 18-in., 2,500 ft.; 16-in., 4,800 ft.; 12-in., 4,200 ft.; 10-in., 16,500 ft.; 8-in., 39,200 ft.; 6-in., 6,800 ft.; 4-in., 1,000 ft. Also, 6,250 ft. of 5-in. screw pipe and 15,000 ft. of 1 to 2-in. service pipe. The total length of pipe in the high-pressure system is 18.5 miles. On this system there are 165 6-in. and 65 4-in. fire hydrants.

The Sewerage System

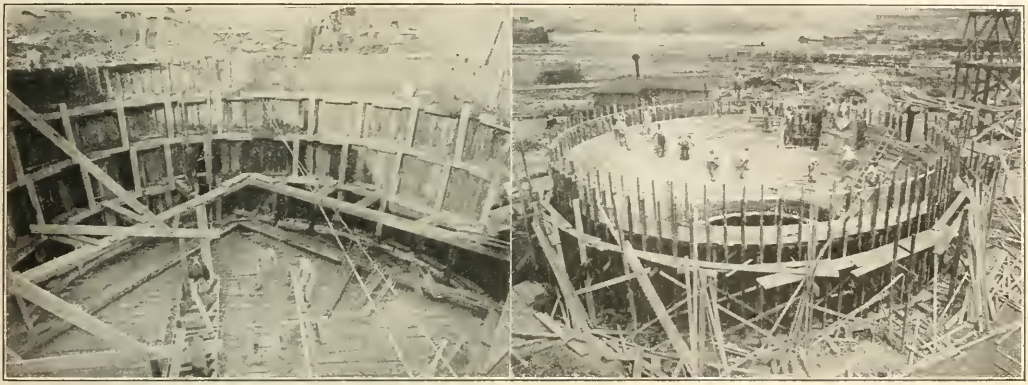
There are two main trunk sewers leading to the sewage disposal plant. Numerous laterals from these trunk lines cover the whole island.

On account of the very flat grades, that the topography of the island made necessary, flush tanks are placed at the dead end of every line. The tanks operate automatically once daily.

Sewage Pumping and Treatment

The sewage is brought by gravity to a cylindrical sump 37 ft. in diameter and 20 ft. deep. This is built of reinforced concrete. Three centrifugal pumps, each 1,500 g.p.m., operated by automatically controlled 25-h.p. motors, pump the sewage into Imhoff tanks. There are two of these tanks, built of reinforced concrete. They are of two-story type. The sludge

storage chamber is cylindrical in shape, with a cone-shaped bottom. The diameter of the cylinder is 29 ft.; the depth to the bottom of the cone is 19.5 ft. The upper portion is in the shape of a funnel 16.5 ft. deep and 49 ft. across the top. The total depth from top of tank to bottom of cone is 36 ft. These tanks each have a capacity of 1,500,000 gals. per day, and afford a retention period of 1½ hours. The effluent flows from these tanks to a disinfectant tank, where it is dosed with chlorine gas, and then through baffles into a small retention chamber, where it is held about 10 minutes. From here it runs through a 16-in. cast iron outfall into the Delaware river, discharging below low tide.



VIEWS SHOWING SEWAGE TANK CONSTRUCTION AT HOG ISLAND, PA.

The sludge is run on sludge beds at necessary intervals. These beds are two in number, one for each Imhoff tank. They are 108x125 ft., and are composed of a filtering material which allows the liquid to run off and thence back into the sewage sump. The sludge dries on the beds and is hauled away for disposal.

At the sewage sump it is possible to pump the sewage directly into the 16-in. outfall, thus by-passing both the Imhoff tanks and the disinfectant chamber. This, however, would be done only in case of both Imhoff tanks being out of service, in which case chlorine would be applied at the sump.

The sewers at the foreign barracks are lower than those in the north end of the other barrack quarters, so it is necessary to have an auxiliary sewage sump here. This is cylindrical in shape, 13 ft. deep and 20 ft. in diameter, and is built of reinforced concrete, and has two 5-h.p. motor-driven centrifugal pumps, each capable of pumping 1,900 g.p.m. They have automatic starters, which start the pumps when the sewage rises sufficiently high in the sump. The force main is constructed of 6-in. wood stave pipe. It discharges into a manhole in the barrack quarters and thence runs by gravity into the main sewer lines.

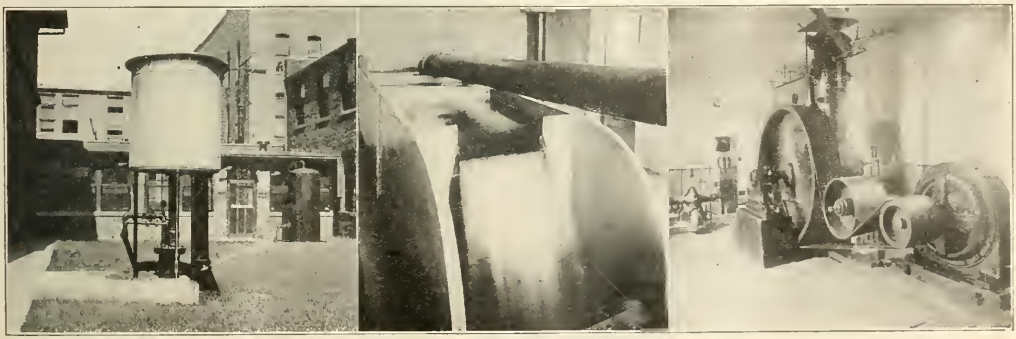
The main lines are from 8 to 24 ins. in diameter and the house connections mostly 6-in. The following is a schedule of the different lengths composing the system:

Wood pipe, 1,350 ft. of 6-in.; vitrified pipe: 6-in., 40,000 ft.; 8-in., 3,800 ft.; 10-in., 16,400 ft.; 12-in., 3,600 ft.; 15-in., 6,400 ft.; 18-in., 2,800 ft.; 22-in., 3,400 ft.; 24-in., 1,850 ft. There is also, in this system, a 1,500-ft. line of 16-in. cast iron pipe. The total length of sewers is 15.4 miles. There are 110 manholes and 18 flush tanks.

Performance of New Air-Lift Pumping Plant at Galesburg, Ill.

By John Oliphant, Chief Engineer, Pneumatic Pumping Department, Sullivan Machinery Co., Chicago

The city of Galesburg, Ill., has had considerable difficulty in securing sufficient water for the public supply. A number of wells in the neighborhood of the old pumping plant have been driven and equipped with various devices, but failed to give the amount of water needed. The old plant consists of three deep and six shallow wells, with a combined yield of about 250



VIEWS OF NEW AIR LIFT PUMPING EQUIPMENT AT GALESBURG, ILL.

Fig. 1, Left: Well and Collector Head in Center of Group of Municipal Buildings, Air Receiver at the Right Outside Engine Room. Fig. 2: Discharge Into Weir Box Over Concrete Storage Basin. Fig. 3: Air Compressor Short-Belt Connected to Electric Motor. At Left is Centrifugal Unit That Pumps Into the Water Mains.

gals. per minute, and has been very expensive to operate and maintain.

Under the present city administration the question of drilling a well at some distance from the old plant was taken up, under the direction of C. W. Whitney, and the Whitney Well Company was employed to drive a well to a depth of 1,250 ft. A strong flow of water was developed.

The New Well

The construction of this well was as follows: 40 ft. of 24-in. heavy steel casing; 106 ft. of 20-in.; 130 ft. of 16-in., and 350 ft. of 12-in. steel casing. The 12-in. is sealed in the rock. The hole was then drilled 12 ins. in diameter to a depth of 1,085 ft. from the surface, then reduced to 10 ins. and drilled down to 1,255 ft. through the St. Peter's sandstone formation.

The well was then shot with two 200-lb. charges of 100 per cent. gelatin, covering the entire sand rock strata, and carefully cleaned out.

Genuine wrought iron 10-in. pipe was installed and sealed into the top of the 12-in. pipe, approximately 350 ft. from the surface of the ground. This extends to within 3 ft. of the top of the sandstone strata, hermetically sealing the well from all water in the strata above the St. Peter sandstone. The analysis made from the water secured from the completed well was superior to that of all other wells in the territory, on account of the sealing off of the upper strata.

At the site of this well an auxiliary plant was constructed, lifting the water from the well to a small surface reservoir by means of the air lift. Thence the water is forced into the mains against 40 lbs. pressure with a centrifugal pump. The air lift and pump are operated by separate compressors.

Air-Lift Equipment

The air-lift equipment consists of one Sullivan angle-compound, Class "WJ-3" compressor, with 16x9¾x12-in. cylinders, arranged with short belt drive and unloading valve; one Sullivan standard 5-in. foot-piece (outside air line), and well-head with umbrella separator complete; one 42-in.x8-ft. vertical steel air receiver, and one 100-h.p. General Electric motor.

A float regulator was installed so that the water level in the receiving basin controls the amount of air delivered to the lift by unloading the compressor and regulating the water delivered to the centrifugal pump, which, in turn, is controlled through an electric governor by the city pressure, making the plant automatic throughout.

Conditions of Operation and Results of Test

The following are the conditions of operation and the results of the test on the well:

Number of wells	1
Depth	1,252 ft
Water pipe in well	235 ft. 3 ins. of 5-in. 330 ft. 9 ins. of 6-in.
Main air pipe in well	235 ft. of 2-in. 331 ft. of 2½-in.

On account of the severe drop an auxiliary starting device was installed at a depth of 481 ft. 8 ins., to pump off the head and keep below excessive starting pressure.

Static head (from ground)	186 ft.
Drop	118 ft.
Elevation above surface	7 ft.
Total lift	311 ft.
Operating submergence	362 ft.
Percentage of submergence	35.8
Depth of pump in well	566 ft.
Operating pressure	121 lbs.
Starting pressure with auxiliary	129 lbs.
Gallons per minute pumped	450
Actual cubic feet of free air used	450
Revolutions of compressor	179
Water horse power, that is, ft. lbs. of work done	35.5
Operating horse power	94
Efficiency per cent	37½

High Efficiency Secured

The percentage of efficiency shown is considered excellent, and this result was made possible by careful proportioning of the sizes of air and water piping, proper location of the foot-piece or pump in the well, and by the use of the improved Sullivan foot-pieces, providing a continuous flow of water. In this design the air is discharged from the foot-piece into the water, in the well casing, in a multitude of fine jets, creating a very thorough mixture or emulsion of air and water. This action secures the maximum efficiency, as the chance of slippage is reduced to the minimum.

The accompanying views, taken at Galesburg, for this purpose, illustrate the new water stations.

Fig. 1 shows the location of the well in a court yard, in the center of the group of municipal buildings. The building at the left is the City Hall, and at the right is the rear of the fire station. The air compressor and pump are in the one-story engine room in the background. In the foreground is the well and collector head, in which the water stands about two-thirds full. The water is discharged in the large pipe at the right and is carried by gravity to the engine room. The air receiver is shown outside the building at the right.

In Fig. 2 is shown the water discharge pipe, coming into the weir box in the engine room. Over this weir the water is measured before falling into the concrete storage basin or cistern.

In Fig. 3 is shown the Sullivan angle compound air compressor, short belt connected to an electric motor. The vertical cylinder and a portion of the intercooler of the compressor may be seen, the low-pressure or horizontal cylinder being obscured by the flywheel. At the left is the centrifugal pump used for forcing the water from the storage reservoir into the city mains.

Mr. J. W. Thompson is chairman of the Galesburg Water Committee.

Recent Developments in Reinforced Concrete Pressure Pipe for Water Supply Lines

By Wallace R. Harris, Engineer Cement Products Bureau, Portland Cement Association, 111 West Washington St., Chicago, Ill.

Reinforced concrete pipe has been used for many different kinds of service, and now the art of manufacture has advanced to a point where a greater range of usefulness can be seen for this product. The progress from a split concrete pipe, for protecting wood piles from the teredo, to a reinforced concrete pipe suitable for water mains has been gradual, but sure.

Most engineers are familiar with the type of reinforced concrete pipe used for sewers, ranging in size from 24 ins. to 108 ins. in diameter, and may also know that reinforced concrete pipe has been designed for subaqueous lines, such as intakes for power house circulating systems, etc., but the latest development of a concrete pressure pipe suitable for water mains was only placed on the market the first part of this year.

Present Maximum Working Pressure

In general it may be said that although reinforced concrete pipe has been made to withstand 110 lbs. hydraulic pressure per square inch under test, such pipe is only furnished for pressures not exceeding 80 lbs. per square inch. Such pipe may be divided into two groups, one ranging in size from 36 ins. to 108 ins. in diameter, the other ranging from 12 ins. to 48 ins. in diameter, the first group being supplied with copper expansion joints and the second with a combination cast iron bell and spigot and lead gasket joint. The copper expansion joint pipe has been used with great success on water conduits

and pressure sewer mains, including the largest job of its kind, which consists of 10 miles of 66-in. pipe and 2½ miles of 48-in. pipe, on the Greater Winnipeg aqueduct, in the province of Manitoba.

Special Structural Advantages

Due to careful methods of manufacture and properly designed reinforcements, both types of pipe have ability to resist internal and external pressures, have a low coefficient of friction, and, due to the expansion joints and to the density of the concrete walls, the leakage is very low and will be found

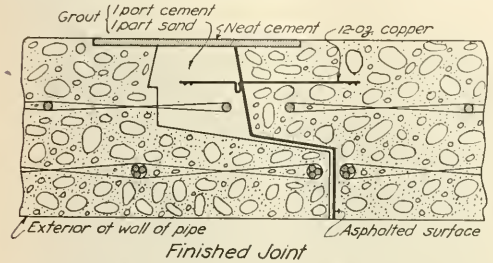


Fig. 1. Details of copper joint in reinforced concrete pressure pipe.

to be within the limits usually set as allowable leakage on water mains. The maintenance charges on such lines will be almost nil, as the line will grow stronger with age and can be considered of greater permanence than any other material capable of rendering similar service.

Two Types of Expansion Joints

The Copper Joint.—The two types of joints will be explained below, to illustrate the difference between the two types, as well as to indicate the advancement made.

In Fig. 1 it can be seen that a copper crimped band is cast in the spigot end of the pipe, so that the V-crimp comes at the top of the spigot, the other half of the band projecting from the spigot into the joint space which is created when two sections of pipe are joined ready for the mortar joint. The copper is roughly perforated along its two edges so that a mechanical bond will be secured with both the concrete in the spigot of the pipe and also with the joint mortar. The edge of the spigot is given a coat of asphalt paint to form a line of parting so the joint mortar will not bond to the spigot face. That part of the bell coming in contact with the joint mortar is roughened and a strand of mesh reinforcement is caused to project into the joint space so as to provide additional means for bonding the joint mortar to the bell end of the pipe. The primary joint, composed of 1:1 Portland cement mortar, is placed in such a manner as to obtain good contact with the copper, and the secondary joint, made of reground neat Portland cement, is placed. When the pipe contracts, due to lowering of the temperature of the water, the secondary joint cracks

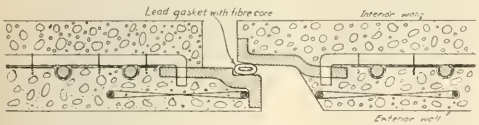


Fig. 2. Lead gasket joint, reinforced concrete pressure pipe. Spigot in position to force home.

at the parting line above the V-crimp in the copper, and, having no bond with the asphalted surface, the joint follows the bell end in its movement toward the center of each pipe and pulls the copper, thereby opening the V-crimp, but still maintaining a tight joint, through which water cannot escape. When the temperature of the water raises the crimp closes. This type of joint has fully demonstrated in practice its usefulness.

Lead Gasket Joint.—Fig. 2 shows a section of the lead gasket joint as the spigot is in position to be forced home. The cast iron rings, which have been turned to a true circle on those faces which come in contact with the lead gasket, are cast integrally in the concrete pipe and are rigidly held in correct alignment by the longitudinal steel rods, which engage respectively in holes provided for the purpose in the cast iron bell and spigot rings. It will be noticed that one of the castings, that in the bell end of the pipe, has been machined in such a manner as to provide a seat for the gasket, which seat has a shoulder against which the lead pipe is forced, and a partly depressed cut forming half of a dovetail. This depression causes the gasket to be thicker at that point than at the edge nearest the outside joint line and prevents the gasket being pulled out of place when the pipes contract. The gasket is prepared by drawing a fiber core into a thin lead pipe, the core being tightly compressed in the act of drawing. This pipe is then flattened, turned into a circle and soldered to an exact circumference. The several points of design mentioned above are necessary to produce a joint which under pressure can be opened for as much as ¾ in., and which will allow the pipes to be deflected as much as 6 or 7 degrees without any leakage occurring.

Fig. 3 shows a section of the joint as it appears with the pipe pushed to place, with the gasket forced to its seat, with a resultant change in cross-section.

This type of pipe, in sizes of from 12 ins. to 48 ins., will be made in lengths of 12 ft., and can be provided with a simple form of service connection, whereby small lines can be connected without leakage while the pipe is under pressure, and which will only require excavation to be carried to the top of the pipe. This construction feature will increase the range of usefulness for this kind of pipe.

The city of St. Johns, N. B., will lay some of this pipe on a 48-in. water line during this year. The Lock Joint Pipe Company, of New York, manufactures these two types of pipe.

Increasing the Well Water Supply of Montgomery, Alabama

By A. O. Beauchemin, Hydraulic Engineer, Memphis, Tenn.

Contract for developing a 2,000,000-gal. well water supply for the city of Montgomery, Ala., was recently awarded to the Layne & Bowler Company, of Memphis, Tenn. This article describes the present well water supply, the proposed development, and gives in brief form the results of the studies made in connection with this development.

Present Well Water Supply

The city's water supply is procured from two sources: the river and deep wells. The river water is used exclusively for industrial purposes. The well water is used for domestic and

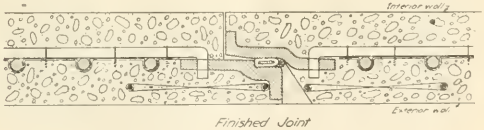


Fig. 3. Lead gasket joint, reinforced concrete pressure pipe. Pipe in place and gasket seated.

industrial purposes. The present well water supply is procured from 18 wells, distributed within a radius of 1,000 ft. from the main pumping plant. The water is procured from three different strata: the 200, 400 and 600-ft. strata. The wells are distributed in groups as follows: Five wells are bored to the 200-ft. stratum, 10 wells to the 400-ft. stratum,

and 3 wells to the 600-ft. stratum. The water is lifted from the wells by means of a 3,000-cu.ft. air compressor direct connected to a 450-h.p. electric motor. From the wells the water is discharged into four concrete surface reservoirs, having a combined capacity of approximately 2,000,000 gals. From the surface reservoir the water is pumped to the city at 110 lbs. pressure by means of a centrifugal pump, directely connected to a 300-h.p. motor. The air compressor and high-pressure pump are in duplicate.

Production

In 1915 the water plane in these wells had been lowered so much as to necessitate a general cleaning of the well screens. An engineer was authorized to make the necessary repairs. The screens were all cleaned out and the submergence of the air line was increased. When these improvements had been made, the total production of the wells was 4,618,872 gals. per 24 hours, and the static head stood at an average depth of 71.2 ft. from the surface of the ground. The working head was then 125 ft. and the average air pressure was 61, with a submergence of 60 per cent. At the date of my investigation, June, 1918, the total production of the wells was found to be approximately 4,000,000 gals. per 24 hours, and the average static head was 89.6 ft., showing a reduction over 1915 of 18.4 ft., and the working head was 149 ft., an increase of 24 ft. over 1915. The average air pressure was 48 lbs. per square inch, a decrease of 13 lbs. since 1915.

Consumption

In addition to its normal consumption, the city of Montgomery has contracted with the War Department to supply Camp Sheridan with a maximum of 2,000,000 gals. of water daily, and the government is now building a large repair camp for aeroplanes, which will require a maximum of 250,000 gals. of water, making a total increase over the normal consumption of 2,250,000 gals. of water, or a total consumption of 6,250,000 gals. daily, while the total present well production does not exceed 4,000,000 gals. In order to meet the increased demand, the city had two alternatives—that is, to procure this additional supply from the present gathering ground or to bore wells outside of the present gathering ground.

The writer was called to investigate these two sources of supply and to report on them. If the additional water supply was procured from the present gathering ground the increase in draw down would be approximately 217 ft. from the surface of the ground. In order to meet this new condition, the air line in every well would have to be lowered in order to have sufficient submergency, and in its several wells which are bored to the 200-ft. stratum the air line cannot be extended. Therefore, the production of these wells would have been greatly reduced. Assuming that the air line could be increased in the other wells, the power required to lift 6,250,000 gals. out of the present gathering ground would be approximately 1,000 h.p., or an increase of 550 h.p. for an increase in production of 2,000,000 gals. In order to lift this water it would require an additional air compressor of 2,000 cu. ft. and one 2,000,000-gal. high-pressure pump. These two units should be in duplicate. Assuming that the draw-down in the wells would increase in the same proportion as during the previous three years, it would mean an increase of 40 ft. in the next ten years, making a total lift in the well of 257 ft., which would be impracticable on account of the high power consumption and the uncertainty of the water supply.

Resume

	4,000,000	6,250,000
Average depth to water level at submergence	47%	50%
H. P. required	450	1000
Cubic feet of free air	3000	5000
Number of wells	18	28

Estimated cost of two 2,000-ft. capacity air compressors directly connected to 600-h.p. motor $56,000
Two 2,000,000-gal. high-pressure pumps direct connected to 150-h.p. motor 10,000
Ten wells to a depth of 600 ft 20,000
Pipe line, ground, buildings, foundation, etc 6,000

Making a total cost of $92,000

The Layne System Adopted

At present the water is pumped at a pressure of 110 lbs. in order to lift the water to the upper part of the city, which is situated at an elevation of over 200 ft. above the main pumping station, and as the city has only one system, the lower town is supplied with water at a pressure of approximately 100 lbs., which is far in excess of the pressure required for domestic uses, with the result that a great quantity of water is wasted through leaks in the pipe line.

The Layne & Bowler Company, of Memphis, Tenn., submitted a proposition whereby they agreed to bore a series of large capacity wells about half way between the main pumping plant and Camp Sheridan. The wells are to be drilled at a distance of not less than 6,000 ft. from the present well location, which will be beyond the radius of influence of the present well system.

The new well system will supply the lower part of the city, situated north of Wetumpka Road, and Camp Sheridan, at a pressure of 70 lbs., thereby reducing the actual pressure by 40 lbs. This will considerably reduce the water wastage due to high pressure.

The Layne system will be connected to a surface reservoir at the main pumping station by means of an 8-in. automatic pressure regulating valve, which will automatically open when the pressure in the water system exceeds 70 lbs. and it will overflow into the surface reservoir, relieving the old well system of that much water.

A 75,000-gal. standpipe will be built at the base hospital at Camp Sheridan, and should, at peak load, the pressure decrease it will be equalized by the standpipe, so that a uniform pressure will practically be maintained throughout the day.

The Layne & Bowler Company estimate that they will produce a total of 2,000,000 gals. daily with three wells, which will be equipped with a Layne deep-well, high-pressure, motor-driven, centrifugal pump. The water from the wells will be pumped directly into the low-pressure system at a pressure of 80 lbs. at the discharge of the pump. Each pump will be directly connected to a vertical motor and the total horse power required to pump the 2,000,000 gals. at 70 lbs. pressure will be 250 h.p.

The well pumping units will be connected by an automatic control and each pump will be controlled from the main pumping house. In case of fire a gate valve, which will connect the high-pressure and low-pressure systems, will be opened, and the two systems will be operated at 110 lbs. pressure at a capacity of 6,250,000 gals. per day.

The new water supply will be located midway between the two points of consumption, which are the lower town and Camp Sheridan, and will have the following advantages: First, reduction in the loss of head due to the pipe friction; second, reducing the lift in the well system; third, reducing the domestic pressure from 110 lbs. to 70 lbs.; fourth, the efficiency of the new pumping system will be approximately 60 per cent. over all; fifth, the new wells will be beyond the radius of influence of the old system.

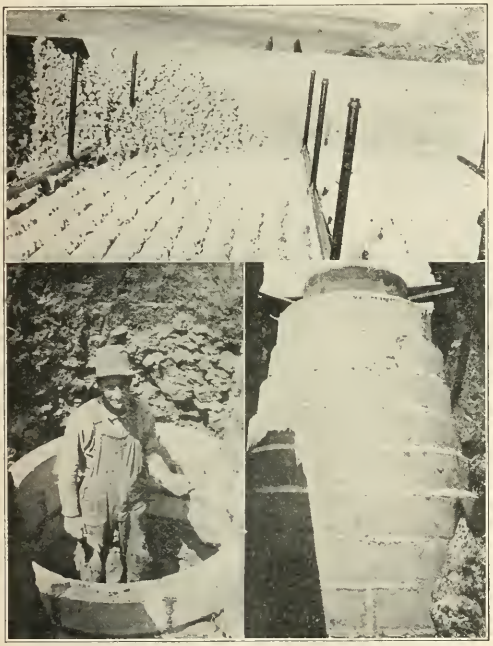
An important feature of the Layne system is that the clogging of the screen or strainer is practically impossible, due to the fact that with this system the velocity of the water entering the well through the shutter screen is so slow that the water does not carry any sand.

Sewer Design and Construction

Novel Sewerage System and Sewage Treatment Plant at Mt. Horeb, Wis.

By W. G. Kirchoffer, Sanitary and Hydraulic Engineer, Madison, Wis.

Mt. Horeb, Wis., claims the distinction of being the first village in Wisconsin to have its entire sewerage system constructed of cement concrete. The sewer pipe was manufactured by the Waupaca Sand and Gravel Company, Waupaca, Wis., and was composed entirely of cement and sand. The specifications followed for its manufacture were almost identical with those prepared by the engineering department of Kansas City, Mo.



VIEWS OF SEWERAGE WORKS AT MT. HOREB, WIS. Top: Sprinkling Filter Under Construction. Bottom: Sewer Manhole of Cement Blocks Under Construction and Completed.

Some of the advantages considered in selecting this pipe were a more perfect joint, a smooth and uniform interior surface which would cause the least deposit, and about 14 per cent. greater carrying capacity than vitrified pipe.

Some of the disadvantages of the use of this pipe, as discovered during construction, are its weight as a drawback in handling, slightly larger and deeper trenches, greater porosity and difficulty in cutting to an exact line or shape at terminal points or in manholes. However, on the whole, we considered the advantages were greater than the disadvantages.

The manholes were all built of cement blocks, cast in an arc of a circle. These blocks, from the contractor's standpoint, at least, were an improvement over brick, considering cost and ease of building the manholes. They should also prove to be will prove whether they will disintegrate faster than brick.

The sewage disposal plant was constructed entirely of concrete. It consists of a settling tank, a sludge digestion chameconomical from the standpoint of durability, but only time ber, a siphon chamber, a sludge drying bed and a sprinkling filter. The plant was designed for a population of 800, with a daily average consumption of 100 gals. per capita. The settling tank has a capacity of a 2½-hour flow, assuming the entire flow to take place in 18 hours. The sprinkling filters have an area of 1,936 sq. ft. and a depth of 6 ft. The sprinkling nozzles are of the square Taylor type, spaced 11 ft. c.c. and operate under a maximum head of 6 ft. The contents of the siphon chamber are such as to cause the siphons to discharge at 20-minute intervals. The daily rate is 1,800,000 gals. per acre.

During the first winter of operation the volume of sewage was so small that all of the nozzles except one row were shut off and this row was housed in with rough lumber and buried with straw and manure. The plant is so located that it has no stream or open water into which the effluent can be discharged. The Galena limestone appears close to the surface at this point, and as it is extremely full of crevices the effluent was disposed of by constructing an underground pipe gallery (similar to galleries for the collection of water in water-bearing materials) on two sides of the filter into which the effluent discharges.

The plant has operated fairly satisfactorily, considering the care which it has received, which has been almost nothing, although the authorities promised the engineer they would care for it faithfully. On account of an excess of untreated creamery water being discharged into this plant, the underground filter has had to be extended, and from a recent date the plant will receive regular attention of a caretaker. The creamery waste will be treated in a specially designed tank before discharging into the sewerage system.

Mt. Horeb is located on a high ridge (known in the early history of Wisconsin as the military ridge), and drains into four dry valleys. This plant is the first one of four to be built and provides sewerage for the business section of the village. Other plants, slightly smaller, will have to be built in the other valley as occasion demands. These plants have not as yet been designed, but when they are needed they will be designed to fit the needs at that time and in accordance with the best prevailing practice, and particularly as may be indicated by the experience with this plant.

The sewers consist of 482 ft. of 6-in., 3,781 ft. of 8-in., 2,750.2 ft. of 10-in., 1,372.7 ft. of 12-in. concrete pipe, and cost $7,732.10. The sewage disposal plant, exclusive of rock excavation, cost $5,320.

Mr. C. H. Phillips, Waupaca, Wis., was contractor, and Ray A. Phelps, resident engineer, under the direction of W. G. Kirchoffer, who prepared the plans and had general supervision of the work.

Design Details of Proposed Works for the Collection and Disposal of Sewage at Pottstown, Pa.

By Charles E. Collins, Consulting Engineer, Drexel Building, Philadelphia, Pa.

In designing the proposed works for the collection and disposal of sewage at Pottstown, Pa., it was found that the

borough could be divided into a high and low level system, which, it is estimated, will ultimately save one-half of what it would cost to pump all the sewage to the disposal plant from one low level intercepting sewer. The borough has, therefore, been divided into two districts, a high level district from which all sewage flows by gravity to and through the disposal plant, and a low level district from which all sewage flows to the pumping station at the sewage disposal plant and is pumped into the settling tanks, from which it flows by gravity, together with the sewage from the high level district, through the disposal plant.

The sewers are designed on the separate sewerage plan; no rainwater from roofs or other areas is to be admitted into the sewers. The sewers are proportioned in size to accommodate the estimated future population on the basis of an average flow of 100 gallons per capita, for 24 hours, with a maximum hourly flow of 1½ times the average daily flow. The sewers larger than 6-in. and 8-in. in diameter when carrying the maximum amount of sewage for which they are designed are to flow between ½ and 2/3 full. The minimum size of sewer is to be 6-in. in diameter; therefore, there will be a large amount of 6-in. pipe that will not flow ½ to 2/3 full.

I have also substituted 8-in. for 6-in. in a few cases where a 6-in. would be large enough, but an 8-in. is more easily inspected, and in the cases where they are substituted for a 6-in. they have sufficient advantage to offset the small amount of extra cost.

The minimum grades are such as will give a velocity of about 2 ft. per second when flowing half full, and with the flushing that they will get from the flush tanks that are placed at the ends of flat sewers, should remain in good condition.

Population

The present population is estimated at 20,000 and the future population is estimated on the basis of 25 persons per 100 ft. of street for all streets within the high level district, and 20 persons per 100 ft. of street for all estimated future streets through vacant lands within the high-level sewerage district; 25 persons per 100 ft. of street for nearly all streets in the low-level sewerage district; 15 persons per 100 ft. of street for those streets not included in the above, and 15 persons per 100 ft. of estimated future streets through vacant lands in the low-level sewerage district, making a total estimated future population of 60,000 people, and the intercepting sewers have sufficient capacity to take care of the sewage from this population when flowing a little more than half full.

Ground Water

No water will be admitted excepting the unavoidable leakage, which is estimated at 135 gals. per 24 hours per 100 ft. of sewers, and in computing the sizes of sewers this amount of ground water is provided for.

Manholes and Flush Tanks

Manholes are placed at the intersection of all sewers and all changes of grades and alignment. Flush tanks are placed at the ends of sewers with flat grades.

House Connections

Connections with the sewers should be made only at Y's left in the sewer for this purpose, and only under the direction of a sewer inspector or superintendent of sewers. All house connections should be made of 4-in. first-class vitrified pipe laid on a grade of not less than 2 per cent.

The town council should adopt rules and regulations governing the making of these connections with the sewers, and also governing plumbing and drainage of buildings.

Care of System

The sewers are designed to be practically self-cleansing, and the grades are such as will produce under ordinary conditions self-cleaning velocities. It does not follow, however, that because a sewer has a self-cleansing velocity, it does not require any attention, because matter is often thrown or in some way admitted into a sewer that should not be, and if allowed to remain there would cause a great deal of trouble. I therefore advised that the sewers be carefully inspected at least twice each year, and if found foul, or in any way obstructed, they should be thoroughly flushed with water from the fire hose and thoroughly cleaned.

Sewage Disposal Plant

The sewage disposal plant consists of a pumping station on the low level intercepting sewer, a small tank in which the sewage from the high level and low level intercepting sewers comes together, an Imhoff settling tank, a small tank between the settling tank and dosing tank, dosing tank, sprinkling filter, effluent settling tank and sludge drying beds.

Pumping Station

The pumping station is a brick structure with reinforced concrete floor and concrete foundation equipped with two double suction centrifugal pumps of the volute type, each with a maximum capacity of not less than 1,200 gals. per minute, direct connected to two electric motors, the shaft of each pump to have a jaw coupling on opposite sides of pumps from the motors. These jaw couplings connect with a shaft on which there is a pulley driven by gas engine, so that the motors may be disconnected and either pump driven with the gas engine. A small air compressor is belted from the coupling between one of the motors and the pump which operates the sewage ejector in the pit below the basement floor.

The sewage from the low level system enters the pumping station at elevation 124.25, passes through two small tanks containing a concrete baffle wall, sloping bottoms and concrete wall over which the sewage passes into the pump well. The purpose of this small tank is to serve as a grit chamber, the heavier matters settling and the larger floating matters being held by the baffle. In the bottom of these tanks are two pipes leading to the small ejector in a pit below the basement floor. At intervals the flow shall be deflected through one of these tanks by the stop plank at the inlet, and the heavy matter, scum and sewage pumped out of the other with the ejector into the force main beyond the pumps, and then the direction of flow changed to that tank and the other tank pumped out with the ejector. In this way the pumping of the heavy grit and coarse floating matter through the pumps is avoided, and it is expected that high efficiency pumps may be operated without trouble and with less cost and repair than could be if all grit and coarse matters were pumped through them. The efficiency of the ejector will be low, but the amount of sewage pumped by this ejector will be very small. The sewage flows from these tanks into a small pump well, from which it is pumped by two centrifugal pumps of the volute type into the small tank outside of the settling tank. At this point the sewage from the high and low level districts comes together and passes by gravity into the settling tank.

Settling Tanks

These tanks are of the Imhoff type and have two compartments, the upper compartment being the settling chamber and the lower the sludge compartment. The sewage enters the tank through the concrete weirs or notches in the concrete channel wall at one end of the tank, passing under a concrete baffle in the center of the tank, and also under the small removable plank baffles at the outlets. The outlets are weirs or notches in the concrete channel wall, the same as the inlets. After the effluent passes out of the tank it flows around one side of the tank in a concrete channel into a small tank and over the side wall of this tank into the dosing tank.

By changing the stop planks that are placed in the concrete channels where the sewage enters the settling tanks, the flow may be changed so that it will pass through the tanks in either direction. As the sewage passes through the tanks the heavy sludge particles sink to the bottom and slide down the sloping walls into the lower compartment, where it undergoes further

decomposition. The tanks are of sufficient capacity so that the sewage will be between two and three hours in passing through the tanks when operating at full capacity, while the sludge compartment is of sufficient capacity to hold the sludge that will be deposited in about six months.

A water pipe is placed in the lower compartment, so that the sludge may be stirred up with a stream of water; this loosening of the sludge aids in the decomposition of the organic matter; the light scum arising on the sides of the sludge compartment may be removed from the top. An 8-in. sludge pipe is placed in the bottom of each sludge compartment for drawing off the sludge that settles in these compartments.

The object of the small tank between the settling tank and the dosing tank is to distribute the flow over the entire end wall of the dosing tank and prevent a heavy volume of sewage from floating down the side of the tank at one point when the tank is empty. Also to give an opportunity to screen the sewage at this point if found necessary, but as I have had a very similar plant in operation for two years without screening the effluent, I do not think screening will be necessary.

Dosing Tank

The sewage passes into the dosing tank, and as it reaches elevation 149.50 it is discharged into the pipes leading to the sprinkling nozzles and is sprayed over the stone filter. This tank is to be constructed of reinforced concrete and will be equipped with a Miller syphon, or equal, which will operate automatically, drawing a depth of 6 ft. in the tank. This is designed to give a maximum head of 8 ft. and a minimum head of 2 ft. on the crest of the nozzles, with 240 Taylor square spray nozzles in operation.

Filter

The filter is a sprinkling filter 20 ft. by 217 ft. 6 in., with a depth of 6 ft. 6 in. at the walls and 5 ft. 9 in. at the center. The walls are reinforced concrete and the floor of plain concrete. The main feeder pipe from the syphon will be 30 in. in diameter, discharging through a tee into a 24-in. cast iron pipe in each direction, reduced to 16 in. in diameter at each end, provided with 8-in. tees for each branch feeder pipe. An 8-in. valve is placed between the main feeder pipe, and these branch feeder pipes are to be 8-in. cast iron pipe and to extend through the opposite wall from which they enter and be fitted with a cap bolted to a flange end, so that the cap may be removed for cleaning. All feeder pipes are amply large, so as to keep the frictional losses low.

Sprinkling Nozzles

The sprinkling nozzles are to be the Taylor square spray nozzle, or equal, attached to a short piece of 2-in. pipe screwed into the flange of a cap bolted to a tee in the feeder pipe. The crest of the nozzles will be 6 in. above the surface of the filter.

Underdrains

The underdrains consist of two channel pipes, the lower pipe to be in 2-ft. lengths, laid to true grades on 9-in. centers and imbedded in the concrete floor; the top channel pipe to be in 1-ft. lengths, laid with 1-in. open joints. These underdrains are on a grade of .073 ft. per 100 ft., discharging through the four walls into a concrete channel in which the effluent flows to one point at the southwest corner of the filter, and from this point in an open channel to the effluent settling tank. The ends of all the underdrains are open so as to admit a free circulation of air through the drains and filter.

Effluent Settling Tanks

These tanks are reinforced concrete walls and plain concrete floors. The effluent passes into these tanks over a weir in the end of each tank, the tanks being of sufficient width and depth so that the velocity of the flow through the tank is very slow and allows any solids that may have flaked off the filter to settle in the tank, while the effluent flows through the pipe to the river. They are so arranged that the flow may be diverted through either tank while the other is being cleaned. These tanks are so located and at such an elevation as will permit dosing the effluent with a germicide in the channel between the filter and the tanks, if this is found necessary or advisable at any time in the future. The dosing tank for mixing and regulating the amount of disinfectant would be in the pumping station, and could be readily so arranged that the operating of the pump would regulate the dosing of the effluent. The effluent, after receiving the disinfectant, would pass into the tanks, giving it ample time to be thoroughly sterilized before passing off to the river.

Sludge Drying Beds

Sludge will flow from the settling tanks through an 8-in. sludge pipe into an open concrete channel, from which it flows through shear gates onto the drying bed. The flow can be regulated and the sludge well distributed through these gates. The surface material of the beds will be coarse sand, under which will be 3 in. of broken stone from ⅛ to ¼ in. in size, and below this the broken stone will vary from 1½ in. to 2 in. in size. Filtering material will average 14 in. in depth. The beds will be drained through 3-in. sewer pipe with open joints, sloping from the side of each bed to an 8-in. drain in the center of the bed. This 8-in. drain will discharge into the 10-in. cast iron clean-out pipe from the high level intercepting sewer, through which it flows into the pump well.

Capacity of Plant

In determining upon the capacity of this plant I have assumed that 80 per cent. of the total population of the borough will be served by the sewerage system in not less than two years after the sewers are completed, and after this time the proportion of the total population being served by this sewerage system will remain approximately 80 per cent. of the total population of the borough. On this basis I have determined upon a capacity of plant for 16,000 persons, although I think it will be found to be of sufficient capacity to treat the sewage from between 18,000 and 20,000 people.

Operation and Care of Plant

The plant is designed to be, as far as practical, automatic in its operation, and I believe will give good results with a minimum amount of care. Pumps will be driven by direct-connecting electric motors. Each motor will be connected with an automatic starter and float switch. This float switch will be set so that the motor goes into operation when the sewage in the pump well reaches a certain elevation, and also stops when the sewage reaches a lower elevation. It is intended, however, that one pump will ultimately remain in operation nearly continuously the greater part of the time. When one pump is in operation the float switch connected with the other motor will be set so that should a break-down occur the motor out of use will automatically go into operation. There is also a gas engine connected between both pumps, so that in case the electric power plant should shut down, the gas engine may be put into use.

After the sewage is pumped from the low level intercepting pump into the small tank outside of the settling tank into which the sewage from the high level intercepting sewer also enters, it flows by gravity from there through the entire plant.

Provision, as described above, is made in the settling tank to reverse the flow, the object being to deposit the sludge as uniformly as possible in the sludge compartment. These settling tanks should be in operation for about eight months before any sludge is drawn off, and then I believe it will be found best to draw off a small amount about once each month except during the colder winter months, when the drawing off of the sludge may be omitted. This should, however, be determined upon by the conditions found to exist when the plant is in operation.

Two attendants in the day and one at night should be sufficient to keep the plant in operation in the most satisfactory

manner. One of the day attendants should be competent to take care of the machinery and see that it is kept in proper condition and properly operated. The work about the plant outside of the pumping station will, in a general way, consist of freeing any nozzles that may become clogged, see that all the channels and dosing tank are kept clean, and do such other work as will naturally come to the attention of any attendant. The high level intercepting sewer should also occasionally be flushed through the 10-in. cast iron pipe in Moser road, also through the 10-in. cast iron pipe along the filter.

The caps should occasionally be removed from the 8-in. feeder pipes and each pipe carefully cleaned with sewer rods, steel brush and scraper. The valve on the 8-in. feeder pipe should be cleaned while the line is being cleaned, and each line cleaned separately. While each line is being cleaned the nozzles should be removed and also thoroughly cleaned.

Water Works Maintenance and Operation

Conversion of Small Steam Operated Pumping Stations Into Electrically Operated, Automatically Controlled Stations

By John W. Toyne, Engineer, 157 Farmers' Trust Bldg., South Bend, Ind.

Public utilities are facing a situation unparalleled in history. The requirements of the government in man-power and materials, both directly and through contracts occasioned by the greatest war of all time, must of necessity come first. However, it is equally essential that the health and energy of our communities be conserved, and to this end the public utilities must render adequate service.

With the coal production below normal, the available labor supply greatly diminished, and the cost of all materials advanced from 100 to 400 per cent., the utilities are compelled, by economic necessity, to give more intelligent consideration to their problems of operation, maintenance and extension than heretofore.

The larger utilities, especially the privately owned, have for some time past recognized the necessity of efficient operation; have made a study of fuels and economical combustion, and have equipped their plants with modern instruments that make possible a comparison of operation results with the most efficient attainable with their type of equipment. They have built up in the personnel of their organization a spirit of loyalty and efficiency that is, under intelligent direction, in a great measure nullifying the handicap of labor shortage and high prices.

Steam-Operated Water Utilities Hard Hit

Perhaps no utility is suffering more from the abnormal conditions obtaining than the steam-operated water utilities serving the smaller communities. In the majority of cases these utilities are municipally owned. They have been constructed without sufficient consideration being given to operating and maintenance costs, and are being conducted in such a manner that economical operation is an impossibility.

A small steam-operated water utility, serving a community of about 2,500, that recently came under the writer's observation, is an example typical of this condition.

The plant consists of a battery of three hand-fired tubular boilers, 66 ins. by 6 ft., set 28 ins. above the grates. The boilers have deteriorated to such an extent that a maximum pressure of only 60 lbs. is allowed by the State Inspection Department. They are being operated without the feed-water being pre-heated in any way. The pumping equipment consists of two duplex, double-acting, triple-expansion engines, of the direct-acting type, operating condensing, with 14-in. vacuum.

This plant is being operated without either draft gages or flue gas analyzer in the boiler room; without a recording gage of any kind; without an indicator for engine valve adjustments, and with no meter on the water discharge line. The operating force consists of two 12-hour crews, three day men and two night men. Such a condition seems improbable to one familiar with efficient operation, yet its occurrence is so predominant in the smaller utilities that it can hardly be considered exceptional.

Electrification Covers a Multitude of Sins

Perhaps no available solution of this problem, under present conditions, is more attractive or economical than that of electrification of the plant with automatic or semi-automatic control.

In approaching a proposiiton of this character an intelligent study of all of the component elements, together with the physical and social conditions obtaining, is necessary in order to really accomplish the desired results. A careful survey must be made of the present and immediate future requirements; to determine the quantity of water to be provided; to analyze the distribution to ascertain the friction head, in addition to the static head, that must be carried under extreme conditions; to study the availability and quantity of the supply in order to determine, on a basis of ultimate cost, the most economical method of pumping; to consider the characteristics of the electrical power, both as to cost and continuity, and to study the social development of the community, in order that future requirements may be anticipated without excessive cost or objectionable operating features.

After a survey of this character has been made, and the general plan decided on, it is important that careful consideration be given to the details, bearing in mind that the total cost of production is the real governing factor.

Cost, as used here, and as must be computed, includes not only power and attendance, but, of equal importance, the items of interest, depreciation and maintenance.

It is manifestly impossible to give any plan that would be susceptible of universal application, especially in an article of this nature.

Example of Successful Electrification

A water utility in the southern part of Michigan offers an excellent example of the results that may be attained by the electrification of a small steam-operated plant. This utility serves a community of about 1,500. The original power plant consisted of a battery of two tubular boilers and two direct-acting, deep-well steam pumping engines.

This plant has been changed to a motor drive, with automatic control. A survey of the source of water supply indicated that one of the old wells should be discontinued, as the two wells had been installed so close together that the area of influence prevented pumping both simultaneously at full capacity, and that a new well must be drilled. This was accordingly done, and the result attained through increased infiltration more than justified the expense incurred.

The pumping engines, motors and pressure-governed con-

trollers were carefully selected on the basis of ultimate cost, and are operating at an over-all efficiency in excess of 75 per cent., which is, taking into consideration that the pumping engines are of the deep-well type, especially good.

The power is purchased at regular commercial rates from a power company operating in the community, and is very reliable, both as to the characteristics of the current and the continuity of the service.

This plant has been in service nearly a year, and to date the labor requirement for operation and maintenance has averaged about one hour daily.

The reduction in cost of operation and maintenance attained in this instance by electrification of the plant, and the change made from manual to automatic control, is slightly in excess of 75 per cent., and the saving effected is paying 40 per cent. net annually on the cost of the improvement.

This is not a brief in behalf of the electrical central stations, neither is it a criticism directed at municipal ownership, for the theory of community ownership of community utilities is above criticism, and the principles involved apply equally, regardless of ownership, whether municipal, corporate or private. It is a plea for an intelligent study of the actual conditions that obtain in connection with each utility and the rational application of the results of such investigations, as in this way only can efficient operation be secured and the resources of the utilities be conserved.

Pumpage of Wasted Water in Chicago Consumes 100,000 Tons of Coal Annually

One hundred thousand tons of coal, enough to heat the homes of 10,000 families through a cold winter, are wasted each year in Chicago in pumping water that is wasted, according to a special report on universal metering for the city, recently issued by the Chicago Bureau of Public Efficiency.

Eight and one-half per cent. of the water accounts are meter accounts, registering 25 per cent. of the water used and 47 per cent. of the city's water revenue, which last year was about $7,500,000.

The report was issued in support of the proposed ordinance then before the city council, which provides for universal metering at no expense to the consumer, retaining the present rate of 6¼ cts. per 1,000 gals., "with a minimum yearly charge of $4 per single household and $3 for each additional occupancy served by the same meter."

Shows Possible Saving

The report analyzed the situation with reference to leaks and wastes and the economical possibilities of a universal meter system, as follows:

Not less than 100,000 tons of coal are consumed annually in the pumping of water that is never used by any one. The need for fuel conservation in the future will be apparent to every one.

Expenditures from the water fund since the beginning of 1915 have exceeded the water revenue by nearly $4,000,000. In 1917 there was a deficit which necessitated the borrowing of $500,000 on water certificates, and it will be necessary to borrow a like amount, and possibly more, during 1918. The present depleted condition of the water fund is due largely to the drain upon it for tunnels, pumps and mains that would not be required but for the excessive amount of waste and leakage which prevails.

If through universal metering this waste and leakage can be brought under reasonable control within the next ten years, as is contemplated by the pending ordinance, the construction of tunnels, pumping stations and mains can be largely stopped for a long period, and the net saving which will result, even after the cost of installing, maintaining and reading the meters is taken into account, will mean that an increase in water rates can be avoided. The aggregate net saving between now and 1950 is estimated at not less than $135,000,000.

Half the Water Wasted

The Chicago water works is pumping an average of 260 gals. of water daily for every man, woman and child in the city. This is about twice as much water per person as most other American cities find ample to supply their requirements. Cleveland and Milwaukee, lake cities where conditions of supply and distribution are similar to those in Chicago, and where universal metering prevails, have a daily pumpage of less than 125 gals. per person. And their service is much better than ours.

Not more than half the water pumped in Chicago is ever really used. The other half is lost through waste and leakage. This loss is due to leaks in the pumps, in the mains and service pipes, and in house plumbing. It is due also in some cases to either careless or willful waste on the part of consumers. Meters are proposed as a means of locating and checking so far as practicable the loss of water which is of no use to any one. They are not intended to discourage the use of water in abundance, and experience in other cities shows that they do not in fact discourage such use.

Refuse Collection and Disposal

Refuse Collection and the Present Demand for Garbage

By Samuel A. Greeley, Hydraulic and Sanitary Engineer, 64 West Randolph St., Chicago, Ill.

Demand for Garbage

With the frequent difficulties attending proper garbage disposal, it is odd to find in many cities of this country at the present time a demand for more garbage. Within the last few weeks the commissioner of public works of Chicago made a public request, through the press, for more garbage, asking that no garbage be burned in furnaces and incinerators that could properly be put into the garbage can. In other cities the demand for garbage is indicated by the enactment of new ordinances for the separation of garbage from other refuse and by measures for improved collection service. Obviously, this demand results from the reduced quantities of garbage and the increased prices of garbage products. These conditions give a new perspective to garbage collection and disposal problems. How may the inherent dangers be avoided and the benefits secured?

Reduced Production of Garbage

As a result of the educational and restrictive measures of the government for food conservation under the able leadership of Mr. Hoover, there has been a marked and quite general reduction in the per capita production of garbage. This reduc-

tion from pre-war quantities has amounted roughly to from 10 to 25 per cent., some specific data being shown in Table I. On the whole, this reduced production is highly desirable and likely, to some extent, to continue.

TABLE I—REDUCED PRODUCTION OF GARBAGE.

City	Periods Compared: Larger Production	Lower Production	Percent Reduction*
Milwaukee	12 mo. 1916	12 mo. 1917	18.7
St. Paul	7 mo. July to Dec., 1916	Same period 1917	16.1
Rochester	12 mo. 1916	12 mo. 1917	20.1
Detroit	12 mo. 1916	12 mo. 1917	7.7
Columbus	12 mo. 1916	12 mo. 1917	21.5
Chicago	12 mo. 1916	12 mo. 1917	24.8
Springfield	1st 5 mo. 1916	Same period 1917	9.9

*Referred to larger production.

NOTE: Percentage reduction is based on total quantities, not per capita quantities of garbage.

Increased Value of Products

The most common products of garbage are pork from disposal by hog feeding, and grease, nitrogen, phosphoric acid, etc., from disposal by reduction. The increase in the market value of these products within the last 18 months has been almost beyond belief. The price of pork on the hoof has risen from $8 to $10 to upwards of $16 per hundred weight, or approximately double its pre-war price. Grease, which in 1914 brought around 4 cts. per pound and in 1917 6 cts. per pound, can now be sold for 11 to 12 cts. per pound. Some pertinent data is given in Table II.

Decreased Quantities of Products

Available records appear to indicate in some communities a moderate falling off in the quantities of products (pork, greases, etc.) recoverable from garbage, such as grease and tankage. This has presumably resulted from the generally adopted food conservation measures, although good business conditions, and, in particular, high wages, are compensating influences.

Separation of Garbage

The demand for garbage has led cities having mixed collection of all house refuse to undertake a separation of the garbage, and cities already having separate collection to seek methods of increasing the efficiency of the separation, so that more clean garbage will be collected. Such cities as Louisville, Ky., Seattle, Wash., Portland, Ore., San Francisco, Cal., New Orleans, La., and others heretofore operating under the mixed or no separation system, have started, or are considering, the separate system for collecting garbage free from ashes and rubbish. These measures obviously require marked changes in the established kitchen routine of many households, as well as adjustments of the collection service to the new demands. The situation offers opportunities for breaking away from costly, inefficient practices—opportunities which should not be overlooked.

Inherent Dangers

The principal danger in the adjustment to new conditions is that half-developed measures will be adopted. The chief source of complaint against refuse collection service in the past may be traced to this consideration. Methods of refuse collection (and disposal) have too often been developed from small beginnings along haphazard lines, following no general plan. The resulting systems are fastened upon cities by long use, despite high cost and inadequate service. Although it is now quite generally recognized that the collection of refuse is the most costly part of the problem and affects the convenience of householders most directly, nevertheless these facts are often overlooked in the operation of collection works. Special attention should be given to the following factors, among others:

Sanitary Requirements: (a) Frequency of collection. (b) Regularity of collection. (c) Service factor. (d) Type of wagon. (e) Washing the wagon. (f) Workmen.

Requirements for Economy: (a) Frequency of collection. (b) Type of wagon. (c) Equipment. (d) Variations in service. (e) Emergency work.

There is also a danger that methods of garbage disposal will not be sufficiently developed. Disposal of garbage by feeding to hogs and by reduction may result in odors and nuisance if the works are not properly built and operated. Over-zealous contractors, official bureaus and others have at times pictured the establishment of hog farms and separate collection systems on too easy terms. Some city officials have at times sought too high financial returns, such as can only be secured at the expense of cleanliness and good service. Rough sledding has been the fate of both contractors and the public. To avoid these dangers there is required a general plan and adequate attention to details.

TABLE II—VALUE OF PRODUCTS FROM GARBAGE.

Year	Market Price of Grease, Cents per Pound: Chicago	Cleveland	Columbus	Market Price of Tankage, Dollars per Ton: Chicago	Cleveland	Columbus
1913	....	4.26c	3.75c	....	$6.00	$6.79
1914	....	4.17	4.32	....	6.75	7.41
1915	....	4.41	3.76	....	8.75	7.00
1916	7.29c	6.50	5.17	$4.16	7.75	8.50
1917	7.34	8.00	7.50	4.16* 10.27**	9.58	10.84
1918	11.57	13.50	11.76	10.27* 16.85**	18.50	20.50

NOTE: *To August 1st. **Balance of year.

Benefits

The most obvious benefit is conservation. By saving the products of garbage the public is enriched. A cheap food for pork becomes available in greater quantities, there is more grease for soap and munitions, and also more fertilizer. The only justification for a deliberate waste of these products is a greater measure of public health protection. Obviously, special care should be taken to adopt methods of collection and disposal of separated garbage which can be maintained and operated in a clean and sanitary manner.

Of only secondary importance, however, is the benefit resulting from the opportunity offered of adopting improved methods of garbage and refuse collection. Frequently methods can be planned for a progressive development which can be partly financed by revenues secured from the garbage products. In any event, an opportunity is offered by the pressure of war conservation to put over improved methods of garbage collection and disposal.

Louisville Data

Since June, 1917, the writer has been consulting engineer at Louisville on refuse collection and disposal work. Through admirable co-operation on the part of Mr. Miller, of the Board of Public Works, Major Fricks, of the U. S. Public Health Service, the members of the special committee of the Woman's City Club and others, much progress has been made. The essential features of the preliminary investigation and recommendations were given in Municipal Engineering for December, 1917. Since that time a new ordinance has been adopted, a new separate collection service has been extended to about 70 per cent. of the city, improved methods for the maintenance of dumps have been introduced and tests of garbage reduction and feeding to hogs have been made.

Of particular interest is the transition from mixed to separate collection. The existing school districts of the city were taken as a basis of organization because the Woman's City Club already had existing organizations in each school district. These districts were subdivided into collection districts, which were the unit for the introduction of the separate collections. Every house in each district was visited, the new ordinance explained, the type of can described, and a kitchen card left with the housekeeper. The permanent collection service then followed. During the first few weeks in the various districts, special records were kept of the number of

houses visited by each wagon, the amount of garbage collected, and other data necessary for planning collection equipment for the most economical service. The result has been a comparatively easy and complete adoption of the separate system. This portion of the work has been directed by Mr. Oeshger, superintendent of street cleaning; Miss Morrell, for the Woman's City Club, and Mr. Wischmeyer, for the Architects' and Engineers' Club.

Summary

There is at present a demand on the part of refuse collection departments for more garbage because of the relatively high prices of garbage products. Cities are introducing the separate collection service and are undertaking to improve their present systems. Opportunities are thus afforded for developing new and better methods. These opportunities should not be overlooked, and, in particular, half-way measures should be avoided both as regards collection and disposal. The resulting conservation of useful and valuable products is most desirable and should be exploited to the utmost consistent with public health protective measures.

Water Purification and Sewage Treatment

Sprinkling Filter System and Auxiliaries vs. the Activated Sludge Process

By T. Chalkley Hatton, Chief Engineer, Milwaukee Sewerage Commission, City Hall, Milwaukee, Wis.

Mr. Kenneth Allen closes his very admirable article on "The Development of Sewage Treatment," published in Municipal Engineering for June, 1918, with the following words: "The means to realize the end should be the one that will be found not only most economical, but the one most generally acceptable from every point of view to those living near the plant, to the riparian owner and to the taxpayer."

This remark has struck the author as particularly appropriate at this period of the world's history, when so many lives are being sacrificed and so much property destroyed to demonstrate once for all the soundness of Christ's declaration that "we are our brother's keeper." We call it "Democracy," but it is really the principle involved in properly caring for the weak that the whole race may be benefited.

Economy to Taxpayer Not the Only Consideration

Mr. Allen suggests that economy to the taxpayer is not the only end to accomplish in providing for the disposition of the liquid wastes from a community, but that the inalienable rights of others must also be considered. A close examination of the practice not only of sewage disposal design, but subsequent operation, in the United States, forces one to the conclusion that in most instances the taxpayer has had the first consideration, and that others should be given only such rights as they might establish in court after an expensive litigation.

Consider for a moment the numbers of communities which have recently been haled into court by owners of property adjacent to the modern sewage disposal plant because of the vile and wretched odors emanating from the plant. The several pleas made by those communities are that the odors are not deleterious to health; or that the plant was established before human habitation in proximity to the plant; or that the design and operation of the plant was the best science could recommend!

Are these sufficient answers to the man who has built his home upon his own property, where he expected the comfort and protection given to his fellow-man in the more populous sections of the community? And are the damages which the courts usually allow him sufficient compensation for the breaking up of his home?

Consider again the riparian owner of a creek or small river The fact of this body of water being a part of his property adds to its value very materially; it is useful to his comfort and welfare when in its natural condition; but when a community befouls it for the benefit of the taxpayer its usefulness to the riparian owner is gone and no damages which the court can give him will compensate him for its loss.

Is this carrying out the principle heretofore stated that we are our brother's keeper? Isn't it rather a good representation of the Kaiser's idea that the State is supreme and the individual rights are merely incidental?

Economic Considerations Given Too Much Weight

Economy has played too large a part in the development of sewage disposal processes up to the present time. Among leading sanitary engineers in the United States to-day it is the almost universal practice to recommend dilution as an important part of any process of sewage disposal, even though dilution may render a natural water course unfit for many of the purposes to which a riparian owner might wish to apply it.

The argument advanced has been that the natural means provided by the water itself should be utilized so far as possible, so long as the riparian owners don't kick; and if they do kick, pay them their price, which is likely to be less than the cost of treating the sewage to such a standard that the natural purity of the streams may be maintained.

The author has always objected to this argument, especially in view of the propaganda rapidly spreading throughout this country for the "city beautiful," by which it is intended to provide all means for the comfort, health and general satisfaction to the citizens of a municipality. If, in accomplishing this, the foul emanations from the municipality are deposited upon its neighbors to annoy them, the "city beautiful" idea is, to say the least, inconsistent.

A few years only have elapsed since most of the street cleaning was left to the natural elements; when garbage was deposited upon ground near the municipality and nature invited to do the rest; when most communities used such a supply of water as might be most available without any artificial treatment; but educational progress has taught us that these practices are inimical to public welfare. Although the cost has been enormous, all well-governed cities now insist upon clean streets, clean and wholesome water and the disposition of garbage without nuisance. Is it not pertinent to ask why the slipshod methods usually practiced in partially treating sewage should not be abolished and the work done right, even though the price may be high?

What Process Will Eliminate Nuisance

Those engaged in the art of sewage disposal are quite aware that disposal can be accomplished without causing a nuisance to anyone, providing expense is not to be the chief controlling element, and the writer believes that the profession will not enjoy the confidence of the public in sewage disposal matters until it insists upon having the disposal completed without nuisance to any legitimate rights.

This statement naturally brings forth the question as to what known process applicable to the average conditions will eliminate the nuisances to others caused by sewage or by the by-products from the methods of sewage treatment plants as now practiced.

It will doubtless be conceded by all readers that few, if any, of the present methods of sewage treatment produce a clear non-putrescible effluent; that all produce a sludge which is undesirable as a daily neighbor and that at times every such method produces odors which are neither pleasant nor wholesome; that the final disposition of the sludge is, after all, the greatest problem in a plant of any considerable size and that these disadvantages have been generally considered inseparable from the art.

With this concession granted it follows that a method of sewage treatment which will eliminate these disadvantages is most desirable providing the cost is not prohibitive and should be given very serious consideration in determining the type of plant most applicable to local conditions.

Comparison of Activated Sludge and Sprinkling Filter Processes

All municipalities in America of any considerable size which have, during the past decade, considered the installation of sewage treatment works have studied fine or coarse screening, sedimentation, sprinkling filters and chlorination, either as units, couplets or in other combinations. Fine screening or sedimentation followed by sprinkling filters and final sedimentation, and in some instances chlorination, briefly describes the treatment now most generally recommended where a non-putrescible effluent is required, and may be taken as the last word in sewage disposal so far as American practice is concerned. The Activated Sludge process, as recently developed, should therefore be compared with the sprinkling system and auxillaries and all others thrown into the discard.

In making this comparison, however, the taxpayer should not be given the primary consideration, but should be placed upon an equal basis with the other interests at stake so far as that may be practicable.

In comparing the advantages and disadvantages of the two processes of treatment the following main items should be considered:

Variation in standard effluent.
Area required for plant.
Loss of head through plant.
Effect of temperatures.
Length of main outfall sewer to plant.
Clarification.
Odors.
Flies.
Disposal of sludge.
Cost of plant.
Cost of operation.

Variation in Standard Effluent

Both processes are susceptible of producing any standard effluent required. In sprinkling filters this can be done by varying the rate of flow through the filters. In activated sludge plants it can be done by the volume of air or contact period or both. This flexibility of either process is a valuable feature in many situations. With the suspended and settleable solids removed there are many periods during the year when a putrescible effluent might with impunity be discharged into running water swollen by spring freshets and polluted by surface scourings. Under such conditions the activated sludge process can be operated at decreased cost, whereas no saving can be experienced with sprinkling filters.

Area Required for the Plant

A well constructed and operated sprinkling filter plant with filter beds from 9 to 10 ft. deep should produce a uniform non-putrescible effluent from the average American municipal sewage at a rate of 2,500,000 gals. per acre.

An activated sludge plant under like conditions with 10 ft. depth of aeration tanks, should produce 10,000,000 gals. per acre and with 15 ft. tanks 15,000,000 gals.

The area required for the auxiliaries (except sludge drying beds), connected with the two types of plants will probably nearly balance; so that the sprinkling filter process will require from five to six times the area required by the activated sludge (exclusive of sludge disposal).

In the majority of cases this is a very important item. It is well known that even waste ground in the proximity of a municipality, when desired for sewage disposal purposes, automatically assumes values out of all proportions to its actual worth.

The Loss of Head Through Plant

The loss of head through a sprinkling filter plant should never be less than 12 ft.; whereas an activated sludge plant can be operated successfully with a loss of head of from 2 to 3 ft. from the surface elevation of the sewage in the grit or screen chamber to the surface elevation of the effluent in the outlet conduit.

In many situations the difference in the loss of head required means installation of a pumping plant with the increased operating expenses, and when a pumping plant would be required in either case it means an additional lift of from 9 to 10 ft.

Effect of Temperature

In climates north of the 42d degree parallel the efficiency of springling filters is reduced from 25% to 33% during the three winter months. To provide against this, extra area of beds should be provided. So far as observed the efficiency of the cultivated sludge process is but little affected by climatic conditions, although the indications are that it does require more air or a longer contact period when the temperature of the sewage falls below 45 degrees F. The evidence so far obtained, however, is not conclusive.

Length of Main Outfall Sewer to Plant

It will doubtless be conceded that a sprinkling filter plant should be located at considerable distance from present and prospective human habitation. This requires, in most instances, the building of a long and expensive outfall sewer to the plant.

On the other hand an activated sludge plant properly designed, built and operated can be built close by human habitations without creating a nuisance, because there are no odors, flies or other nuisances to offend the senses, which extend beyond the boundaries of the plant.

Clarification

The effluent from the best operated sprinkling filter plant cannot be said to be clear. So far as the author has observed, its turbidity runs from 40 to 75. The effluent from a properly operated activated sludge plant will carry a turbidity of not more than 90 and usually 95 to 98. In fact the clarity of the effluent produced from this type of plant is one of the wonders which attracts both the learned and novice.

This feature is of decided advantage because it does to a large extent create in the minds of the public a confidence that a satisfactory treatment is being given to the sewage.

Odors

There can be no doubt in the minds of anyone that sprinkling filters and their auxiliaries produce odors, at times, which are unpleasant and inimical to the comfort of persons coming in contact with them. These odors emanate from the preliminary settling tanks of whatever type, sprinkling filters and the sludge.

With a properly operated activated sludge plant no odors are produced which can be detected 200 ft. from their source. In fact, after operating a testing plant for 3 years, the author

has not been able to detect any unpleasant odors 150 ft. from the plant, and yet the sludges produced have been reduced to a fertilizer base by methods where the necessary refinements for reducing odors were not used.

Flies

Sprinkling filters produce myriads of flies and worms. It is questionable whether these become a nuisance to the surrounding neighborhood, but they do, at least, produce an unmitigated nuisance to those whose duties require them to work in and about the plant. Neither flies nor worms are produced about an activated sludge plant.

Disposal of Sludge

In most instances the disposal of the sludge from a sewage treatment plant is the most difficult problem to solve. There are few locations where the sludges can be disposed of as easily and with as little nuisance as at Atlanta, Rochester or Fitchburg, although it must be taken into consideration that this ease of disposal was the result of constructing long and expensive outfall sewers, part of the cost of which should be added to the cost of sludge disposal when comparing the two processes.

Under the ordinary local conditions, whether the sludges to be handled are produced from plain sedimentation, hydrolitic, or two-story tanks, this handling involves considerable labor, and costs, exclusive of overheads, from $2 to $5.50 per 1,000,000 gals. of sewage treated, so far as the author can determine from the meager information he has been able to accumulate.

The sludges produced from plain sedimentation, hydrolitic or Dortmund tanks are wet and putrid when exposed to the atmosphere, and must be lagooned, trenched, discharged upon low ground enclosed with dikes or deposited in separate digestion tanks; in every such case the odors arising from the decomposition are unpleasant and penetrating to a considerable distance.

The sludge from the two-story tanks is free from odors which carry to any considerable distance and can be removed from the tanks at such seasons of the year when climatic conditions are most favorable for drying. These are features which make the two-story tank attractive particularly in the northern sections of America, although there are but two or three months out of the 12 when the climatic conditions in the northern tiers of the United States are such that this sludge can be successfully dried within reasonable time, say from one to two weeks.

Even at the Baltimore plant, where numbers of separate digestion tanks have been provided, large additions to the sludge drying beds have been made to enable the operators to get the sludge dried within the period of the year when it can be done successfully. In municipalities such as St. Paul, Indianapolis, Milwaukee, Chicago, Detroit, Cleveland, and other northern cities, where the volume of sludge produced would be of considerable magnitude, the author is of the opinion that the ordinary sludge drying bed for sludges produced from two-story tanks would prove a failure, and that the Pratt glass covered beds or some such scheme would have to be adopted.

Lagooning, trenching, filling low lands, digestion tanks or drying beds require surface area and this area must be added to the area required for sprinkling filters, and depends upon the character of soil in the first three types, and the normal climate and size of digestion tanks provided in the last two types. Sludge drying beds have generally been provided on the basis of one-half to three quarters of one acre per 1,000,000 gals. of sewage treated. To a plant treating a daily flow of sewage of from 5,000,000 to 10,000,000 gals. or less this additional area does not assume so much importance, but when the daily flow runs up to 50,000,000 or more gallons the area required for sludge beds and that for the final disposition of the dried or partially dried sludge is a matter of great magnitude.

Reducing sludges produced from sedimentation tanks of one type or another to a fertilizer has been attempted in many instances with more or less success. The most recent instance of any magnitude is the operation at Baltimore where the partially dried sludge which has accumulated from the sludge drying beds since the beginning of the operation of the plant is being reduced to a low grade fertilizer by a contractor who has installed a primitive drying plant consisting of direct heat dryers, grinders and screens.

Mr. Reuter, superintendent in charge of the plant, informed the author in September, 1917, that he was producing the dried fertilizer at a cost of $2.82 per dry ton, exclusive of overheads, that it was sold to the fertilizer dealers for $2.50 per unit of available ammonia, and that it contained from 1.25 to 2 units per ton. Not a very attractive business, it is true, but the trouble seemed to be twofold—the crude and expensive method necessarily used in much of the plant and the low grade sludge.

The author was impressed with the great benefit enjoyed by the city of Baltimore from this operation. It was getting rid of a sludge, without expense to the city, which threatened in time to cover all its available ground with an undesirable product. It was getting rid of it without nuisance to its neighbors, and was adding to the wealth of the community by conserving those fertilizing values which would otherwise be utterly wasted.

The disposal of the sludge from an activated sludge plant becomes entirely a mechanical or industrial problem, and must be so recognized to make the process applicable to any condition.

As a wet product there is far more volume to be handled than is produced from any other process of sewage treatment; probably three to four times as much as is produced from chemical precipitation. When fresh it is odorless, but, being highly organic, decomposition begins soon after it is exposed to the atmosphere, and this character precludes it from being dried in the atmosphere. It constantly accumulates and must be handled as rapidly as possible. There are disadvantages of no mean proportions connected with the activated sludge process.

On the other hand the sludge, when reduced to a fertilizer base, contains from 4 to 5 units of available ammonia, which, during pre-war times, was worth $2.50 per unit, and is now much more valuable. From experiments made in Milwaukee and Chicago it can be dewatered by means of pressing and drying at a cost equal to or less than its selling value, and its value as a fertilizer has been practically demonstrated by Dr. Bartow at the University of Illinois, by Col. Nasmith's and Dr. McKay's experiments at Toronto, by Mr. W. Jones, of Stourbridge, England, and by the author in the vicinity of Milwaukee.

The equipment necessary to handle the sludge from a 100,000,000 gal. plant would occupy approximately three acres and would consist of settling tanks, press, dryer and storage houses.

In comparison with the sprinkling filter process the activated sludge process solves the sludge problem by compulsion without creating any nuisance to the neighborhood, and conserves those values of which the agricultural community always stands in need. This advantage is of value not only from the viewpoint of dollars and cents, but from the broader economic view of conservation.

Cost of Plants

It is a difficult matter to compare the cost of any two disposal plants fairly on the basis of volume of sewage treated. There are local conditions which usually require added expense in one which do not prevail in the other. Unless these

Table I—Construction Cost Comparisons of Sprinkling Filter and Activated Sludge Plants.

Comparable Items.	Sprinkling Filter Plants, Gloversville.	Fitchburg.	Activated Sludge Plant, Houston.
Capacity of plant in million gallons	3	4	10
Total cost exclusive of land and engineering	$164,036	* $263,036	$301,526
Cost of plant per million gallons	54,680	65,700	30,152
**Approximate area in plant (acres)		4.17	1.0
Approximate gallons treated per acre	1,000,000	2,000,000	10,000,000
Approximate loss of head in feet	16	25.4	3.5

**Exclusive of ground required for final disposition of sludge.
*Exclusive of sand filters.

are well understood any such comparison is subject to doubt.

It is often most difficult to secure reliable information as to the actual cost of constructing a sewage disposal plant. The amount of contract can be determined, price of land occupied and cost of special machinery and equipment, but there are many other items such as engineering, inspection, superintendence and other contingencies entering into the cost which are so frequently omitted from any published statements.

For these reasons, and because the three plants chosen for comparison are, in the writer's opinion, the best of their type both in construction and in operation, he has taken the Gloversville, Fitchburg and Houston, Texas, plants. The first two are fine examples of the sprinkling filter type and the last the only large plant now built of the activated sludge type.

In comparing the cost of the plants the cost of the sand filter beds in the Gloversville plant has been omitted because it is not a part of the sprinkling filter system, but an auxiliary necessary for the treatment of the special character of sewage produced from the large number of tanneries, and is not common to other sprinkling systems; although it might be said that the sand filters tended to reduce the depth of the stone beds and to that extent reduced their cost.

The activated sludge plant at Houston has been in operation for about a year, at least the sewage treatment part of the process has been, the sludge reduction plant is now being installed, all necessary contracts therefore having been made under certain definite guarantees as to the cost of product, power, fuel and labor required.

It has been treating an average daily flow of 5,000,000 gals. of domestic sewage with little industrial waste, and has been producing, according to Mr. E. E. Sands' written statement to the author, a relative stability of about 70. Comparative Table 1 has been compiled from tables and information contained in American Sewerage Practice, Vol. III, pages 620 and 621, by Metcalf & Eddy, and from detailed statement of cost submitted by Mr. E. E. Sands, city engineer of Houston.

Cost of Operation

It is more difficult to secure accurate cost of operation than the cost of construction, and few data are available for comparative purposes. The three plants above cited, however, are exceptions to the rule, and will therefore be used.

The cost of disposing of the sludge in Houston is compiled from Mr. Sands' statements and are based upon the contract prices for machinery, installation, building, and the guarantees as hereinbefore mentioned.

The cost of operating the Fitchburg plant is taken from the 1917 Annual Report of the Sewerage Commission.

The cost of operating the Gloversville plant is taken from American Sewerage Practice, pages 624, and excludes the cost of removal and replacement of the filter covering.

In estimating the overhead expenses for the Houston plant liberal allowances have been made to cover maintenance. For instance, 5 per cent. depreciation has been allowed upon all machinery and 25 per cent. on Filtros diffuser plates. Cost of power has been taken at 1 ct. per kilowatt hour, the price now being paid by the city. Fuel for drying sludge has been assumed to cost 1 ct. per 82,000 B.t.u. Evaporation of 1 lb. of water per 1,350 B.t.u., or about 10 lbs. per pound of coal.

The writer prefers to have his reader draw his own conclusions as to the advantages or disadvantages of the two methods of sewage treatment discussed in this article. He has presented the facts as they have been presented to him during the last three years of intensive study and observation of the sewage disposal problem. He believes, however, that the activated sludge treatment solves the problem far more satisfactorily to all parties concerned than the sprinkling filter process, where a stable effluent is required and where power costs are not excessive.

Design and Construction of the New Water Purification Plant and Pumping Station at Checotah, Okla.

By V. V. Long, Benham Engineering Company, Consulting Engineers, Colcord Bldg., Oklahoma City, Okla.

After many delays, due to construction in war times, Checotah's new water purification plant and pumping station were placed in operation on June 8, 1918.

The plant is located on Deep Fork, seven miles southwest of Checotah, and consists of a low-service pumping station or intake well, coagulating basins, filters, and high-service pump house and clear well. The filtered water is discharged by the high-service pump through a 12-in. cast iron bell and spigot main into a concrete reservoir, from which the water flows by gravity through a 12-in. flow line to the city. A gravity head

Table II—Comparison of Cost of Operating Sprinkling Filter and Activated Sludge Plants.

Comparable Items.	Gloversville.	Fitchburg.	Houston.
Capacity of plant—Basis for computation	3,000,000	4,000,000	10,000,000
Overhead, 5% interest, 2½% depreciation	$11.24	$13.50	
Overhead, 5% interest, 3½% depreciation			$7.02
Operating costs, including sludge disposal	5.56	6.93	7.08*
Total costs per million gallons	16.80	20.43	14.10

*The total operating cost for reducing the sludge at Houston is estimated to be $8.40 per dry ton. One-half a dry ton is produced to million gallons of sewage. The value of the dry sludge is estimated at $11.25 per dry ton, or $2.50 per unit.

of 70 lbs. per square inch is maintained in the business section of the city.

The new plant has a normal capacity of 1,000,000 gals. per day. Both high and low-service pumps are in duplicate, each pump having a capacity of 750 gals. per minute. The pumps, as well as all the machinery, are motor-driven. The power is generated by the local light company in Checotah and delivered to the plant by transmission line.

There are four filter units, each 11½ ft. by 11 ft. Three units are now equipped, one unit being left for future equipment when required. There are two coagulating basins, each 23 ft. 6 ins. by 59 ft. by 13 ft. deep. These basins are so arranged as to be very flexible in operation and therefore especially adapted for treating water in all conditions. The basins can be used either in series or parallel, and one can be used while the other is being cleaned. Of special interest are the two agitators, which receive the raw water from the low-service pumps, and in which the water is treated with the chemicals and thoroughly agitated. Excellent results are obtained by the use of these agitators and the basins operate very successfully even when the raw water is at its worst stages.

Attention is called to the so-called "red water" which frequently is carried by Oklahoma streams and which is difficult to treat satisfactorily. In treating this "red water" better results were obtained by using lime and iron as coagulent than by the use of aluminum sulphate. The plant is equipped for using both iron or alum as coagulent, but it is anticipated that iron will generally be used. Three inches of head are necessary for the passage of the water through an agitator, when operating at the rate of 750 g.p.m., and the total loss of head from the entrance to the agitator to the water level on the filters, when operating at the rate of 750 g.p.m., is 8 ins., when the basins are being operated in series.

The water works improvements, which include the water purification plant and pumping station, discharge mains and flow lines to the city, cost approximately $130,000. Contracts were let for these improvements during April, 1917. The Tolbert Construction Company, of Muskogee, Okla., were the general contractors. The Pittsburgh Filter Manufacturing Company, of Pittsburgh, Pa., furnished the filter equipment, and the Merkle Machinery Company, of Kansas City, Mo., furnished and installed the pumping and electrical machinery. All the improvements were designed, and the construction supervised, by the Benham Engineering Company, consulting engineers, Oklahoma City, Okla.

VIEWS OF NEW WATER PURIFICATION WORKS AT CHECOTAH, OKLA.
Left to Right: Construction of Forms for Coagulating Basins—Intake Well, Low Service Pumping Station—Coagulating Basins and Filter House.

Design and Construction of the New Sewage Treatment Plant at Sedalia, Mo.

By Robert E. McDonnell, of Burns & McDonnell, Consulting Engineers, Interstate Bldg., Kansas City, Mo.

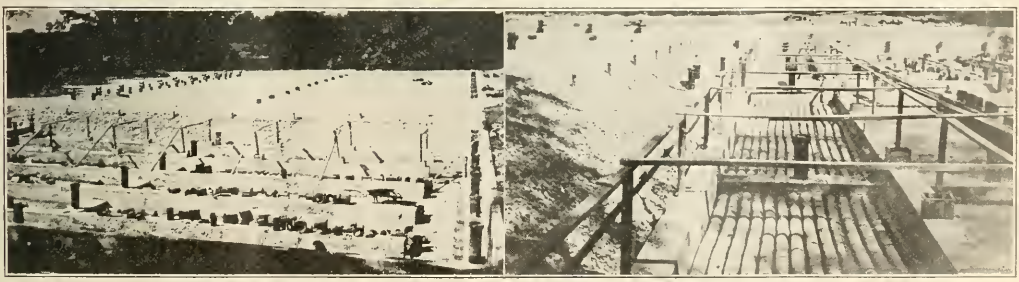
Sedalia is a city of nearly 20,000 population, located in the west central portion of Missouri. It is principally a residential city, and there are very few manufacturing enterprises; however, the Missouri Pacific and Missouri, Kansas & Texas Railroads have large shops located there. Sedalia is in the midst of a rich agricultural district and serves as a market outlet for this territory.

Early Plant Satisfactory

About eight years ago the city constructed a sewage treatment plant consisting of septic tanks and single contact beds, with a capacity of about 100,000 gals. per day, to serve the southeast portion of the city. This method of treatment was adopted on account of the low head available for a gravity plant, and has proved very economical and satisfactory for the local conditions. The septic tanks were provided with sludge drains, and advantage has been taken of times of high water in the creek to flush out the deposits so that the tanks have never required cleaning.

Prolonged Litigation

The sewage from the northwest portion of the city was long emptied without treatment into a creek on that side of the city. In 1895 a farmer above whose land this outlet was located began legal action against the city to secure damages



VIEWS OF SPRINKLING FILTER, SEDALIA, MO., SEWAGE TREATMENT PLANT.
Left: View Taken During Construction. Right: Distributing and Underdrainage System.

and prevent the pollution of the stream. From this time on the case was continually in the courts for over 20 years; the case was tried four times in lower courts and each time was appealed to the Supreme Court, by which it was remanded three times for new trial in the lower court; change of venue was also secured twice. One count was finally decided by the Supreme Court, but the second count never was settled. A few years ago the farmer who brought the suits died, and the estate made a proposition to the city to donate three acres of land on the farm to be used as a site for a modern sewage treatment plant, and agreed to dismiss the suit in the courts. The result of this proposal was that the city engaged engineers to design such a plant. It is probably safe to say that during the prolonged litigation in the courts the city spent one-third or more of what a treatment plant would have cost.

The district from which the sewage is treated in the northwest plant comprises practically all the commercial and industrial portion of the city, and a considerable portion of the residential portion, with an area of approximately 240 acres, most of which is closely built up.

The New Plant

The sewer system is a combined system receiving both sanitary and storm sewage. The dry weather flow was intercepted at the outlet of the brick sewer and carried on down the creek through a 24-in. pipe to the treatment plant. Weir measurement of the dry weather flow taken continuously for three days indicated an average flow of about 850,000 gals. per day, but a yearly average was estimated to be around 1,000,000 gals. per day. The plant was designed for a total capacity of 1,500,000 gals. per day in order to provide for the possible increase during a period of 10 to 15 years.

Since the final effluent was to be discharged into a small stream having very little flow during dry periods, the type of plant selected was such as to prevent unsightly deposits, pollution of stream by decomposing matter and injury of water for stock purposes. The plant as constructed consists of an interceptor and grit chamber, Imhoff tanks, sludge beds, dosing tank, and sprinkling filters.

Intercepting and Grit Chamber

Since the sewer system is a combined system and the treatment plant is designed for the sanitary sewage only, a combined intercepting and grit chamber is provided, so that the operation of the plant will not be interfered with by a great inflow of storm water during rainy periods and by the collection of sand and gravel in the Imhoff tanks. The entrance chamber contains two weirs, so that when the flow exceeds the rated capacity of the plant the surplus will overflow the second weir and pass directly to the stream. The sewage passing the first weir enters a grit chamber 20 ft. long and 8 ft. 6 ins. wide, with hopper-shaped bottom, so that the velocity is reduced to approximately 1 ft. per second, allowing the heavier street washings to settle. These deposits can be periodically removed or flushed out into the by-pass. A bar screen with ½-in. openings is provided in the outlet from the grit chamber to intercept the largest floating and suspended matter.

The Imhoff Settling Tanks

The Imhoff tanks are rectangular in form and divided into two separate tanks, so that either one can be put out of use at will. Each tank is 73 ft. long, 25 ft. wide and 21 ft. 6 ins. deep from surface of sewage to bottom of sludge chamber. The capacity of the flowing-through chambers is designed for a 2-hour retention period on the basis of the average flow. Each tank has a bottom consisting of five hoppers, each 14 ft. square at the top, 2 ft. at the bottom and 3 ft. 6 ins. deep. The sludge chambers have a combined capacity of 15,220 cu. ft. figuring up to 1 ft. below the slot. The gas vent is formed by a continuation of the hopper walls and is 2 ft. wide and 3 ft. above the sewage level extending the entire length of the tank. Equalizing parts are provided across the gas vents at each end to prevent any tendency of fresh sewage stirring up digested sludge due to unequal flow and head on weirs.

The sewage enters the inlet channel at one end and flows over eight weirs 30 ins. wide into the tanks, and passes out over eight similar weirs of removable iron plates into the outlet channel. The inflow will be about 6 ins. deep, allowing floating material to pass, and when reversal of flow is desired the iron plates can be transferred from the outlet weirs to the opposite end and the sewage will then flow through channels around the outside of the tanks. Scum walls extending 18 ins. below the sewage surface are provided at each end of the tanks to retain floating matter.

Each sludge chamber is provided with an 8-in. cast iron sludge draw-off pipe, through which sludge is withdrawn under a hydrostatic head of 4 ft. 6 ins. below the sewage level. The base of this sludge pipe is enlarged by a 16x8-in. reducer

VIEWS OF SEWAGE TREATMENT WORKS AT SEDALIA, MO.

General View of Plant—Imhoff Settling Tanks—Sprinkling Filter in Operation.

and the top is carried up vertically to the top of the gas vent. Gate valves are provided on each sludge pipe just outside the Imhoff tanks, and the remainder of the lines is vitrified pipe.

Sludge Drying Beds

The sludge flows to two sludge drying beds, each 73 ft. long and 20 ft. wide, the inlet pipes being 18 ins. above the surface of the beds. These beds are located parallel to the Imhoff tanks, one on each side and 5 and 10 ft. away, respectively, and are inclosed in vertical concrete walls varying in height from 2 ft. 6 ins. to 9 ft. 6 ins. above the footings, to conform to the final fill around the plant. The filtering material consists of 6 ins. of sand over a layer of gravel varying in thickness up to 6 ins. over the top of the underdrains, which consist of three lines of 6-in. drain tile laid 6 ft. apart and draining into the

main by-pass around the plant. The bottom of the beds was graded so as to slope 6 ins. toward the drains. The capacity of the beds was proportioned on the basis of a four months' storage in the tanks, figuring .0035 cu. ft. sludge per capita per day for 10,000 population, and a depth of 18 ins. on the sludge beds.

Dosing Tank

The effluent from the Imhoff tanks flows through an 18-in. pipe to a covered tapered dosing tank, 15 ft. square on top and 9 ft. by 3 ft. at the bottom and 6 ft. 10 ins. deep inside. An 18-in. siphon with a drawing depth of 4 ft. 6 ins. is set in the floor of this tank and automatically discharges the contents of the tank to the amount of 7,000 gals. about every ten minutes through a 24-in. sewer, incased in concrete, to the sprinkling filters.

Sprinkling Filters

The sprinkling filters have an area of about 0.6 acre and are 184 ft. long and 146 ft. wide, the width being controlled by the topography of the ground. The filters are designed to operate at the rate of 2,500,000 gals. per day, with an average depth of rock of 5½ ft., and varying in size from 1 to 2½ ins. The limestone rock for the filters and also for concrete aggregate was obtained from a quarry in the hillside about 200 ft. away.

The floor of the filters is of plain concrete, 4 ins. thick, over which 6-in. split drain tile underdrains are laid 7½ ins. center to center and on a slope of 1:50 toward the two main drains. The walls of the filters are 6 ins. thick at the top, 8 ins. at the bottom and 6 ft. 6 ins. high, not designed to be self-supporting, but only to separate the earth and stone, hence requiring equal fill outside and inside during construction.

The main distributer is of 24-in. vitrified pipe, and the laterals of 8-in. vitrified pipe, both incased in concrete. Each lateral is controlled by an 8-in. gate valve near the main. Three-inch galvanized pipe is used for the risers and distribution is effected through 252 Taylor square spray sewage nozzles spaced 10 ft. centers. The main drains are of 15-in. split sewer pipe. The bed is ventilated by means of 8-in. sewer pipe risers, surmounted by one-quarter bends, there being 110 vents in all, partly over the box vent chamber at the upper ends of the lateral drains and partly over the main drain.

Provision is made for by-passing the entire plant or the filters only. Final discharge of the effluent from the plant is into the creek only a few feet from the filters. The total head from the invert of the sewer entering the intercepting chamber to the lower end of the main drain from the filters is 14 ft. 8 ins.

Personnel and Costs

The contract for the construction of the plant was let in November, 1916, to J. W. Menefee, of Sedalia, for $50,000, and the plant was completed in the fall of 1917. The plans were prepared by Burns & McDonnell, consulting engineers, Kansas City, Mo., who also drew the plans for the southeast plant, and the construction work was supervised by F. T. Leaming, city engineer, of Sedalia.

The average cost of the various parts of the plant per 1,000,000 gals. capacity was as follows:

Intercepting and grit chamber	$ 350.00
Imhoff tanks	10,600
Sludge beds	1,200
Dosing tank	650
Sprinkling filters	19,800
Piping	700

Drainage and Irrigation

The Use of Vitrified Clay Pipe for Irrigation Lines

By V. E. Piollet, Spokane, Wash.

Vitrified clay pipe is a suitable material to use for distributing the water in irrigation districts. A description of the methods of manufacturing vitrified pipe is thought to be in order, as engineers, while of course familiar with its use, may not know just how it is made. Either fire clay or shale makes an excellent pipe when properly selected. Deposits of good shale or fire clay are not numerous. The clay is mined and delivered at the storage shed at the plant. From this shed it goes into revolving screen pans, which grind the clay, and it is then elevated into a bin. From this bin it goes to what is known as the "wet pans," where water is added. This process is known as tempering. Now it is again elevated to the press, which is a large cylinder with a plunger. The die is placed on the end of the cylinder with a former. The plunger is forced down by high-pressure steam, the bell is formed and then the former is released and the cylinder of pipe comes out of the die. The pipe is formed and pressed out under pressure, which insures a close, dense body, without voids.

The pipe is taken from the press and put on the drying floor, where heat is applied for several days, until practically all the moisture has left it; then it is set in a down-draft kiln and the heat gradually raised until it reaches the point of vitrification, which occurs just before the pipe would melt if one continued to raise the heat. Salt is then put on the fire, causing a vapor to form, which gathers on the pipe and makes the glaze. The heat is held until the pipe is thoroughly glazed, and then it is allowed to cool slowly to avoid cracking from too sudden change of temperature. After the kiln is cool, the pipe is taken from the kiln and loaded for shipment. Arriving

USING VITRIFIED CLAY PIPE IN IRRIGATION LINES. Motor Trucking the Pipe to the Trench—A Well Laid Line Ready for Backfilling.

at destination, the pipe is drawn and distributed along the ditch; motor trucks are much used for this purpose.

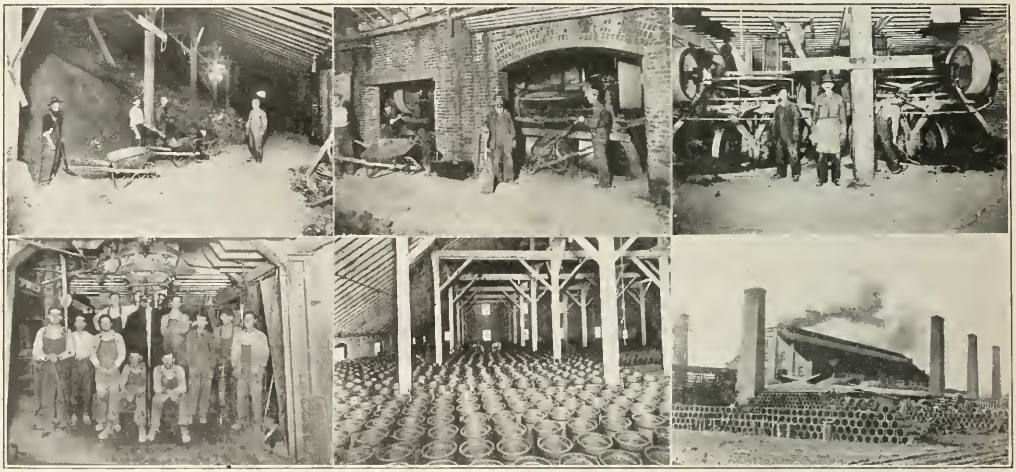
Making Good Joints

To secure a well-laid pipe line, one must obtain, first, a good foundation; second, a straight, smooth interior, and third, a well-made joint. For the pipe foundation, make a space a little deeper where the bell or joint comes, so that the

pipe will rest on the solid ground its entire length. After the pipe is jointed, tamp carefully.

There are several methods of making a joint and a great deal of the success of the system will depend upon the care with which the joints are made. Cement or asphalt are generally used and good joints can be made with either. The best practice in making the joint is to use the "pouring method." The type of mold most generally used is composed of a series of overlapping sheet metal plates, strung on two steel cables of small diameter.

After observing all the usual precautions in the support and alignment of the pipe in the trench, the first two lengths of pipe are placed in the trench, with the spigot end of one thrust well into the socket of the other. The joints are caulked with oakum and the oakum compacted with proper tools all around the joint, to form a gasket and prevent the flow of the joint material into the interior of the pipe. The mold is dipped in oil to prevent the grout from adhering to it, then passed under and around the joint and clamped in such a position that a firm grip is taken on both pipes, with enough



VIEWS OF REPRESENTATIVE VITRIFIED CLAY PIPE FACTORY.
Top Row: Clay Storage Shed—Dry Pans—Wet Pans. Bottom Row: The Press—Drying Floor—Exterior View of Factory.

overlap on the socket to insure an even and maximum space for the joint material. The funnel, of course, should be on top. Sufficient molds must be provided for one day's work. Molds are clamped onto the entire number before any are poured. Cement for the joints should consist of one part by volume of Portland cement and one part clean, sharp sand of medium fineness, and mixed with sufficient water to give a consistency of thick cream.

Molds are left in place from 12 to 24 hours, to permit the cement to take its initial set. The mold unclamps in such a manner as to split the funnel or hopper into two parts, leaving a protruding jet of surplus joint material, shaped like the funnel. Joints made by this method will cause practically no trouble, and when the line is put in operation, will not develop leaks.

Pipe should be laid deep enough so that it will not be disturbed in plowing and the water will not freeze, if, by accident, any is left in the pipe after the irrigation season is over.

Limiting Pressure

Vitrified pipe should never be used where high pressure is developed. While it will stand 35 to 40-ft. head, it is not practical, and it is recommended to limit the head to 12 to 15 ft. for sizes from 4 to 10-in. and to 8 to 10 ft. for 12 to 24-in. The engineer will so lay out the system that none of the pipe will be subject to a greater pressure than that just given. There are numerous methods of breaking the head. The most common of these is, where the pressure is equivalent to much over the head mentioned, to break it by constructing cut-offs or inserting a valve in the main supply pipe at about the point where the pressure should be broken, and then regulating the flow with this cut-off or valve. It is important that vent holes be provided to allow the air in the pipe lines to escape when the water is first turned on, to prevent "water hammer," which would rupture the pipe line.

If the contour of the tract to be irrigated is irregular or rolling, high-pressure pipe should be used to siphon the water over deep cuts. This pipe will not be as permanent as vitrified pipe, but the system can be so designed that only a small proportion of high-pressure pipe will be needed. The main trunk line will, of course, follow the highest ground. Valves or control chambers are placed along the trunk line where each lateral line connects. Other valves and weirs for measuring the water going to the sub-laterals that deliver water to each owner are built, tapping the laterals at the highest elevation on each individual's property.

In extremely large irrigated districts the main trunk line can be constructed to carry any quantity of water by laying more than one line in the main trench. For instance, say the maximum amount of water needed is 40,408 gals. per minute and the fall is 1 ft. in 100 ft. It is found that a 30-in. vitrified pipe will carry 20,204 gals. per minute, 1-ft. fall in 100 ft., thus two 30-in. pipe lines will be needed. Sub-trunk lines would probably start with a 24-in. pipe and reduce down to 20-in. to 18-in. to 15-in. pipe. Laterals start with 12-in. and reduce to 10 to 8-in. pipe, and sub-laterals start with 6-in. and distribute with a 4-in. line.

Vitrified pipe has many advantages for irrigation. It is impervious to moisture, due to the density of body, vitrification and the glaze. It will not disintegrate, and vitrified pipe lasts for many decades. Its smooth glaze or glassy surface offers the minimum of friction and assures a maximum carrying capacity for a given diameter. Vitrified pipe is not adversely affected by alkali.

Most manufacturers have improved their pipe and are now furnishing what is known as the "deep and wide socket pipe," which is the same as the ordinary bell and spigot pipe, with

the exception that there is more annular space and a deeper bell, which naturally makes it easier to secure a strong and lasting joint. Both the spigot and bell are corrugated or scarified, offering an excellent surface for the cement to adhere and forming a key when filled with the cement.

Vitrified clay pipe is being used more and more for irrigation systems where permanency is desired. There are systems installed by the U. S. Reclamation Service that have been in use for 14 years, and they are as good now as on the day they were finished, and have cost practically nothing for upkeep in the meantime.

Results of the Irrigation Work of the U. S. Reclamation Service

In 1917 the 29,000 farmers on 1,000,000 acres of land reclaimed by the U. S. Reclamation Service, Department of the Interior, went over the top with a crop valued at $50,000,000.

The production capacity of the American desert after irrigation is emphasized when the results of the farmers of irrigated lands are compared with those of the humid states. The 1917 crop from reclaimed lands exceeds in total value by $11,000,000 all the crops of Maine, as shown by the census reports of 1909. It is greater by $7,000,000 than the combined crops of New Hampshire and Vermont, and only $4,436,000 less than the total crop values of Massachusetts and Connecticut.

$50 per Acre Gross Average of Irrigated Crops

The gross average of $50 per acre for crops grown on the government's irrigated farms is remarkable when compared with similar statistics for all farms in the United States, the average yields of which in 1909 were only $16.30 per acre. Such returns should at least allay the apprehension, if any now exists, that these farmers will not be able to return the investment of money which has been made by the Government in constructing the irrigation systems. On several of these projects a single crop will suffice to return the entire investment.

Present Status of the Reclamation Work

The summation of the activities of the Reclamation Service to date shows that work is under way on 30 projects, in 15 states. These projects embrace aproximately 3,112,655 acres, or 60,331 farms. Water is now available for 1,750,000 acres in 37,103 farms, and the construction of the necessary works to reclaim the balance is proceeding as rapidly as the limited funds will permit. As fast as water can be made available for the public lands in these projects, the settlers flock to them and the demands are usually in excess of the supply. Land hunger is increasing with the rapidly rising price of farm lands, and the better prices for farm products. In view of this condition and considering the imperative need of an enormous increase in food products, the importance of quickly extending the field of reclamation is obvious.

Resume of Engineering Works to Date

A brief resume of the engineering works to date is illuminating. Since the organization of the service in 1902 it has to its credit many notable achievements. Several of the structures are monumental in character and rank with the greatest engineering works of the world. The engineers of the service have successfully completed the highest masonry dam, the longest tunnel, and the largest reservoir for irrigation ever built. Across the desert they have extended a canal system 10,313 miles long, in which whole rivers are carried and turned upon the land. The huge reservoirs in the mountains, with a combined capacity of 9,000,000 acre-feet, hold back the floods of many streams. Twenty-six miles of tunnels penetrate the mountains, and through two of these, two rivers are carried outside of their own drainage basins. The surplus and waste waters are disposed of by means of drains and ditches having a length of 1,247 miles.

The volume of the dams is 13,258,729 cu. yds., and the excavations of rock and earth for canals and foundations reach the great total of 154,016,449 cu. yds., or about 60 per cent. of the total yardage of the Panama Canal.

In the construction of the several irrigation systems it was necessary to dig 391 wells having a total depth of more than 6½ miles. More than 13,000 bridges and culverts of steel, concrete and wood were constructed, which end to end would extend 74 miles. Canal structures of wood and concrete number more than 85,000. Pipe lines and flumes long enough to reach from New York to Washington and back again are now in place.

The Service has built and operated 82 miles of standard gage railway, 2,871 miles of telephone, and 442 miles of transmission lines. In order to begin construction on many of the important works it was necessary to build an aggregate of 932 miles of wagon roads.

The power plants of the Service have developed 48,093 h. p., which is utilized in construction and leased to many municipalities and individuals. More than 1,200 buildings of all sorts have been erected for the accommodation of the employes and for other purposes. During the period of engineering work the Service has laid out and established eleven town-sites, several of which are today thriving business centers.

BRIDGES AND BUILDINGS

Cost of Painting Steel Highway Bridges in Iowa

By C. E. Smith, County Engineer Henry County, Mt. Pleasant, Iowa

A painting crew organization for the purpose of keeping the old steel bridges in the county properly painted has been in existence in Henry county, Iowa, for several years. A summary statement of the cost of doing this work in 1917, and a brief description of the crew, are here given.

Crew

The crew consists of a foreman and one or more laborers, who are provided with all necessary paint, brushes and tackle, and a team and wagon for transportation purposes. One of the laborers acts as teamster. The prevailing wage last year for these crews was: Foreman, 37½c per hour; laborers, 27½c per hour; team and wagon without driver, 47½c per hour. These crews were operated during the months of May and June.

Painting

The paint used was C. R. Cook's sublimed blue lead, white lead used on hand rails and end posts. All exposed surfaces were cleaned with steel wire brushes and given one coat of field paint.

Costs

Detailed costs on each bridge are available, but only the summary data for the entire year are presented here. The

bridges painted were principally I-beam spans and pony truss spans with wood and steel joists.

Total length of span painted	2,485 ft.
Number of gallons of paint used	271
Cost of paint per gallon	$ 1.80
Total paint cost	488.70
Total labor cost	695.53
Cost of brushes	20.00
Total cost of season's work	1,184.23
No. lineal ft. of span per gal. of paint	9.17
Cost per lineal foot of span	4.76

How Motor Trucks Saved $15,000 for Contractor on Building Excavation

In excavating for the construction of one unit of the Henry Ford Hospital in Detroit the contractor removed 16,000 cu. yds. of material at 45 cents per yard, by the aid of a motor truck, and this unit cost using teams would have been $1.33. Thus the saving due to motor haulage on this job amounted to about $15,000.

The Detroit Excavating Company were contractors on this job with "Con" Devers of the firm, in direct charge. He has had charge of the work of excavating for many of the large buildings erected in Detroit in recent years. This company has been operating in Detroit long enough to be thoroughly conversant with the cost of both horse and motor haulage. At present they can get a one-horse team with driver, capable of hauling 2 cu. yds. at a load, for $8 per day. They know that for $25 per day they can operate a motor truck on this class of work with a capacity of 5 cu. yds. per load.

In figuring on the Ford Hospital job they found that their nearest dumping place for the excavated material was three miles distant from the building site. They knew that horses could make a 6-mile round trip 3 times daily while motor trucks could make ten 6-mile round trips daily, so they decided in favor of motor haulage.

The main excavation was 620 ft. long with a T at either end 200 ft. long. In addition to this there were several 18 and 30 ft. extensions. With an average depth of 5 ft., this made 16,000 cu. ft. to be excavated.

Most of this dirt had been at one time filled in and was therefore uneven strata and held considerable moisture. It was necessary to build a plank roadway the whole length of the excavation, owing to the wet condition of the dirt, to keep the heavy motor trucks from mireing. The plank alone for this roadway cost over $800.

The comparative cost of team and truck haulage figured out as follows:

Length of haul, 6 miles.

One Team

Size of load (cu. yds.)	2
Number of trips per day	3
Total yards per day	6
Cost of hauling 6 yds	$8.00
Cost per yard with horses	1.33

FEDERAL TRUCK HAULING EXCAVATED MATERIAL, HENRY FORD HOSPITAL CONSTRUCTION, DETROIT, MICH.

One Truck

Size of load (cu. yds.)	5.5
Number of trips per day	10
Total yards per day	55
Cost of hauling 55 yds	$25.00
Cost per yard with trucks	.45

Several makes of trucks were used on this work, among them several Federals. The two views herewith show a Thew shovel loading the trucks, and a loaded Federal negotiating the steep excavation grade. This grade was about 20 per cent.

"We were the first company in Detroit to use trucks for removing the earth from excavations," said "Con" Devers, "and we do not know what we would do without them now. On this job alone, it would have made our price nearly $15,000 more if we would have had to use horses. It seems like only yesterday when we had no other means of hauling except the horse, and we wonder now how we ever got along, but at any rate, we could not work with the speed and certainly that we can with trucks."

VIEW OF THREE-SPAN, DOUBLE DECK BRIDGE ACROSS KANSAS RIVER, AT KANSAS CITY, KANS.

Wyandotte County, Kansas, Builds Large Double-Deck Steel and Concrete Bridge

By F. W. Epps, Bridge Engineer, Kansas Highway Commission, Topeka, Kans.

The bridge recently built by Wyandotte county, Kansas, herewith illustrated, consists of three 250-ft. double-deck spans across the Kansas (Kaw) river at Kansas City, Kans. The lower deck accommodates trucks and passenger traffic and is level with the ground at both ends of the bridge. The upper deck accommodates lighter traffic and two street car lines, which run out onto a viaduct 2,000 ft. long on either side of the river.

The lengths of the spans were determined by the requirements of the Kaw Valley Drainage Board, which place the harbor lines 734 ft. apart and allow only two piers between these lines. The trusses are riveted at all points, the ends being carried on pins supported on heavy steel shoes or rockers. The decks are of concrete covered by paving.

The concrete viaduct work was designed along as simple lines as possible, no attempt at ornamentation being made except such as could be added without increasing the cost. All corners are rounded off and columns are built in the form of a cross, which adds somewhat to the beauty of the viaduct. No surface finish was used on the concrete after the forms were removed, but as these consisted of 2-in. tongue-and-groove lumber, the surface was left fairly smooth.

The total cost of the structure was about $850,000, of which $320,000 was spent on the bridge across the river, $168,000 on the east approach, $112,000 on 700 ft. of the west approach and $250,000 on the remainder of the west approach. This last part was paid for jointly by the city of Kansas City, Kans., and the railroads operating under this portion. The balance of the structure was paid for by the county of Wyandotte.

The bridge and viaduct approaches were designed by Harrington, Howard & Ash, consulting engineers, Kansas City, Mo.

FROM WORKERS IN FIELD AND OFFICE

Features of Proposed Sewerage Works for St. Augustine, Florida

To the Editor: It was with interest that I read the article in your July issue, on page 17, entitled, "Features of Proposed Sewerage Works for St. Augustine, Fla."

I was city engineer of St. Augustine, Fla., when this report was submitted with their proposed plan. The plan they submitted was not approved, and in my opinion it would be a serious mistake to adopt the plan that was prepared by Alvord & Burdick.

The portion of your article that refers to the point that we differ on is found in the paragraph at the bottom of the first column, on the page mentioned. They say it is impossible to sewer the central part of the city by gravity, and accordingly three automatically controlled, electrically operated pumping stations will be required in that area.

The city can be sewered by gravity and I have prepared a plan that shows how it can be done.

The city of St. Augustine is situated on a peninsula, lying between two rivers. The average width of the city is about 4,000 ft. The portion of the city that Alvord & Burdick say cannot be sewered except by pumping has an elevation of 6.5 ft. above mean tide. They contend and planned that the minimum grade for 8-in. terra cotta pipe should be 0.25 ft. fall per 100 ft. I agree with them in this. If 8-in. pipe should be used for the shortest distance to the central part of the city, a distance of approximately 2,200 lin.ft., it would require a total fall of 5.5 ft. This would not leave enough cover, and the pipe would hardly give the necessary fall for the house connections. This is the reason why they recommended the use of pumping plants.

I am proposing to use 10-in. terra cotta pipe, laid on a 0.20 ft. fall per 100 ft., and cut out the pumping plants. There is not enough sewage to make the pipe flow two-thirds full, but I have proposed to overcome this by sinking five artesian wells. Artesian wells can be sunk anywhere, and the water will flow up to an elevation of over 20 ft. above the ground. A flow of 300 gals. per minute is easily secured.

I will secure for the distance mentioned above a fall of 4.40 ft., which will give me the same elevation as proposed by Alvord & Burdick at the head end of the line. By my plan the cost of pumping the sewage is eliminated and there will be a considerable saving by cutting out the plants. The substitution of 10-in. pipe in place of 8-in. pipe and the sinking of the wells will cost about half what the pumping plants would cost.

It is not often that one of us little engineers will buck up against the big fellows, but I feel that I have them bested, and I am going to save the taxpayers of St. Augustine thousands of dollars.

Mr. Henderson, mentioned in your article, was city engineer at one time, but not at the time when the report was submitted. I am at the present time assistant state highway engineer, in charge of the work in five counties, and the intentions of the city authorities of St. Augustine, Fla., are that as soon as the war is over I am to go back to St. Augustine and put in a sewer system as planned by me.

Very truly yours,

Holts, Fla., July 7, 1918. P. G. Ekman, C. E.

(Our correspondent's letter was brought to the attention of Alvord & Burdick, and their reply follows.—Editor.)

To the Editor: We thank you for the opportunity of replying to Mr. Ekman's letter re the proposed sewerage system for St. Augustine, Fla.

We will take up the items mentioned by Mr. Ekman in the order in which they are brought up in his letter.

First—Mr. Ekman states that the portion of the city which we have proposed to serve by pumping has an "elevation of 6½ ft. above mean tide," and, further, that the average width of the city is about 4,000 ft., making a distance something over 2,000 ft. to the nearest outfall. This statement, in so far as it refers to elevation, is in error. The following street intersections are in approximately the center of the city and immediately adjacent to the Ponce de Leon and the Alcazar Hotels:

Intersection.	Elevation above mean tide.
Cordova and Savilla	5.1
Cordova and King	6.1
Cordova and Palm Row	5.5
Granada and King	5.7
Granada and De Soto	4.9
Granada and Cedar	5.0
Treasury and Spanish	4.5

The average elevation of these intersections (which are in the heart of the city and of the district from which we planned to pump the sewage) is only about 5¼ ft. above mean tide.

Second—Mr. Ekman proposes to use 10-in. sewers instead of 8-in., on account of the fact that a smaller minimum grade may be used for the larger sized sewers. He loses sight of the fact that for very small flows, such as will take place in the St. Augustine sewers, increasing the size of the sewers is a step in the wrong direction, as the proportional velocity for small quantities of flow in the 10-in. sewers at a .2 per cent. grade is less than in the 8-in. at a .25 per cent. grade, and, accordingly, the liability to clogging is increased. If pumping is used, the 8-in. sewers can in most cases be laid at steeper grades and less flush tanks built.

Third—It is absolutely impracticable to use grades as low as .2 of a foot per 100 ft. for 10-in. pipe without the installation of flush tanks. The system proposed by Mr. Ekman will require approximately 25 flush tanks over those outlined in our report, which will cost at the present time in excess of $2,000. He proposes to furnish the water for flushing by sinking five artesian wells, but loses sight of the fact that additional flush tanks cannot be served by five wells without the installation of a water distribution system between the wells and the several flush tanks. This will necessitate an expenditure of not less than $2,000 per mile at the present time, and several miles will be required.

Fourth—The substitution of 10-in. pipe for 8-in. in order to use the flatter grade, as proposed by Mr. Ekman, would incur an additional expenditure of about $750 per mile of sewer. The 8½ miles of low-level sewers, therefore, if changed from 8-in. to 10-in., would cost an additional amount of $6,500 above that estimated—an amount in itself only $2,500 less than the cost of constructing the pumping stations as recommended in our report.

Fifth—We have gone into the St. Augustine matter fully and are convinced that the most practical method of sewering the central part of St. Augustine, which lies at an elevation of only 5¼ ft. above mean tide and approximately 2,000 ft. away from the water front, is by the installation of automatically controlled, electrically operated pumping stations, as outlined in our report.

Your article, July issue, was correct in stating that Mr. Henderson was the city engineer of St. Augustine, as he held that position for about two years, and was acting in that capacity during the time our report was prepared. Mr. Henderson resigned shortly before our report was submitted.

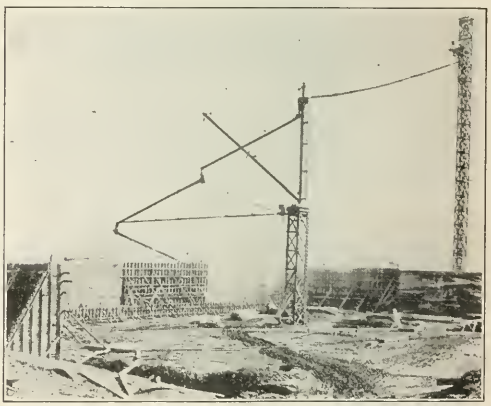
Very truly yours,

Alvord & Burdick,
By L. R. Howson,
Principal Assistant Engineer.

Chicago, Ill., July 11, 1918.

Concreting the East St. Louis & Interurban Water Company's Reservoir

To the Editor: The inside measurements of the new reservoir of the East St. Louis & Interurban Water Company, at East St. Louis, Ill., are 196x220 ft. The walls are 23 ft. high. It was necessary that the walls be poured first, after which a 5-in. layer of concrete was placed over the bottom of the basin in alternate squares. After a layer of asphalt water-proofing had been placed on the first layer of concrete, a second 4-in. layer of concrete was poured. The concreting equipment here illustrated eliminated all cumbersome floor tripods and reduced operating costs and time to a minimum. The method of construction demanded that concrete be placed at widely separated points at different times, so flexibility of concreting equipment was requisite.



VIEW OF SPECIAL INSLEY CONCRETING EQUIPMENT EMPLOYED ON CONSTRUCTION OF NEW RESERVOIR FOR EAST ST. LOUIS & INTERURBAN WATER COMPANY, EAST ST. LOUIS, ILL.

After a comprehensive investigation covering the merits of the different possible means of handling the job, the American Construction and Securities Company, the contractors, decided upon the installation designed for their consideration, which is clearly illustrated by the accompanying half-tone.

A tower approximately 140 ft. high was erected outside of the reservoir at a point where it was convenient to assemble the mixing plant and the necessary raw materials. A guy derrick, supported on a tower approximately 50 ft. high, was erected at a central point inside of the work. The guy derrick carried a mast hopper of special design, which both slides and rotates on the derrick mast and 150 ft. of chuting, 100 ft. of which was of the special Insley double counterweight design.

Concrete was hoisted in the main tower and chuted into the mast hopper by means of the continuous line chutes illustrated, and from the mast hopper was chuted into place by means of the derrick supported chuting. The fact that the mast hopper could be raised and lowered on the derrick mast made it possible to raise or lower the entire chute line, this being done in such a manner as always to maintain the correct slope of chutes while pouring the concrete at different elevations.

While the mast hopper and derrick-supported chute arrangement is novel, the real success of the installation is attributable to the double counterweight chutes. Through the employment of these chutes 100 ft. of chuting is provided which is entirely self-supported from the derrick, and no fixed overhead or ground supports at intermediate points were required for chute supports. The installation was therefore absolutely flexible in that the pouring end of the chutes could be shifted to any point of the work in a few moments' time; its adoption resulted in the pouring of the concrete with maximum efficiency—that is, in minimum time and with minimum labor—by equipment which involved but a reasonable capital expenditure.

Very truly yours,

Indianapolis, Ind. CARL S. WAGNER.

Sulphuric Acid from Nitre Cake

To the Editor: In rereading my article on "The Development of Sewage Treatment," I note an inadvertent error on page 248 of MUNICIPAL ENGINEERING for June, where, in referring to the Miles process, the text says, "By the use of sulphur dioxide, which may be obtained from nitre cake." This should read, "By the use of sulphur dioxide or *sulphuric acid*, which may be obtained from nitre cake," sulphur dioxide being obtained by burning sulphur or pyrites. Nitre cake at present is more available, as it is a by-product in the manufacture of explosives.

Very truly yours,

KENNETH ALLEN,

New York, N. Y. Sanitary Engineer.

Successful Use of Portable Asphalt Plant

To the Editor: We had under operation one of the 1,250-yd., 3-unit Cummer portable asphalt plants at Atlantic City last year, and found that this type of plant is very efficient and economical and will do all that the makers guarantee, and even more if it is properly handled. We have laid as high as 1,600 sq. yds. of 1½-in. surface with this plant in 9 hours; also, 1,500 to 2,000 sq. yds. of 1½-in. binder in 9 hours.

The plant, if properly equipped with gravity asphalt feed for conveying the hot asphalt to the mixer, can be operated with less labor than any plant we have ever used. The capacity of an asphalt plant depends upon the amount of dry material that the drum will furnish to the mixer, and the type of drum that is used on this plant has ample capacity to keep the mixer running steadily without delay. It handles wet and frozen materials as well as some of the larger railroad plants. This type of plant will keep a good sized grading and concrete gang busy on the street to keep out of its way.

Very truly yours,

WARNER-QUINLAN ASPHALT CO.,

Buffalo, N. Y. By PERRY G. HYDE, Supt.

Omaha Considering Municipal Ownership of Gas Plant

To the Editor: The city of Omaha contemplates municipal ownership of the gas plant. A condemnation court has been appointed to hear values of the property and the city of Omaha has retained Burns & McDonnell, consulting engineers, to make an inventory and appraisal of the entire property, to be presented before the condemnation court. A franchise of the present plant expires in the near future, and it is expected to have the appraisal presented the condemnation court before the expiration of the franchise.

This is of interest, inasmuch as Omaha is the largest city in the United States to take definite steps toward municipal ownership of the gas plant. Richmond, Va., and Duluth, Minn., are two of the largest cities now having municipal ownership of this type of public utility.

Omaha is encouraged toward such ownership from the success of the last six years with the municipal ownership of the water works. The city has reduced the rates about 60 per cent and is enjoying excellent service. The city of Omaha has now under construction a municipally owned ice plant, to be operated in conjunction with the water works plant.

Very truly yours,

BURNS & MCDONNELL.

Kansas City, Mo. By R. E. MCDONNELL.

GENERAL ARTICLES

Division of Engineering Established by United States Employment Service

Of special interest to technical men is the announcement of the recent establishment of the Division of Engineering, United States Employment Service, at 29 South La Salle street, Chicago. The principal purpose of this new department is to conserve the services of technical men and to make them available for military and industrial needs. This plan is to be accomplished by means of registering, classifying and distributing technical men, and through an intimate consideration of their interests. Men will be placed, as a result, according to their training, experience and ability.

In view of the growing importance of the engineer and the technical man in the present war, the plans of the Division of Engineering represent great sociological and national values. The engineer is one of the most powerful forces in the development of war apparatus, cantonment sanitation and army transportation. His accomplishments are many and varied. To use his services economically is a patriotic measure.

Registration

In order to accomplish its great work, the Division of Engineering will register all technical men as soon as possible. Those desiring to register for emergency government work or for permanent advancement in positions meeting their qualifications, are urged to apply at once for blanks to the office of the Division of Engineering, 29 South La Salle street, Chicago.

The Director

A. H. Krom, who was recently appointed Director of Engineering, United States Employment Service, is especially well fitted for his new work. As former secretary of the American Association of Engineers he made the affairs of

technical men his principal interest and has gained a thorough knowledge of their affairs, their accomplishments and their ideals. He has been untiring in his efforts to gain deserved recognition for engineering as a profession, and has been eager to give the public a proper understanding of engineering activ-

A. KROM.
Director of Engineering, U. S. Employment Service.

ities. He is a graduate of the School of Engineering of Purdue University. He has recently acted as a recruiting agent for the government and has lectured extensively throughout the country in the interests of the war and its relation to technical men.

Advantages Gained by the Contractor in Employing a Consulting Engineer

By Ray S. Blinn, First Assistant Engineer, U. S. A. Ordnance Department, Camp Perry Proving Grounds, Box 308, Port Clinton, Ohio

During the last ten years I have noticed an increasing demand for engineers to act as advisers to contractors. During that period the writer has had his share of contractor clients.

The fact is that the contractor who worries along without expert advice cripples his actions to a large extent. He should at least retain an engineer if it is only for the reason naively expressed by one of my clients, who said: "I just got to have some one to talk over my plans with." In that casual remark lies a goodly amount of the reliance and confidence that an engineer can give the manager at times when decisions are being reached. This is really the basic idea in the employment of engineers by contractors. Many contractors are pretty good "deciders" themselves, but they need the backing of technical knowledge.

The Engineer's Function Is to Give Advice

The consulting engineer, however, should be the adviser, and not the judge, in money matters. The financial whys and wherefores are strictly the province of the man who has his money invested. The consulting engineer can easily become a nuisance when he oversteps his duties as adviser to insist on methods that might cause financial embarrassment to the contractor.

But when, in the flurry of the work, there are tables of costs to be made out, no amount of experience or intuitive judgment on the part of the contractor can displace the consulting engineer, who can then be of unlimited service to the contractor.

Typical Points on Which Engineer Advises Contractor

In my experience as a contractor's adviser I have encountered such problems as these:

1. Knowing the character and amount of excavation and distance to spoilbanks, one near involving cost of ground and one farther away involving pay salvage, which one to choose and what method to employ without buying additional equipment.

2. The right amount to invest in machinery, taking into account the time of completion and the probable skilled and unskilled men obtainable.

3. The kind of equipment justifiable, considering the total amount of work to do, depreciation and salvage.

4. The right number of men to be assigned to certain parts for economy.

5. To what extent it is necessary to distribute costs.

Limitations of Cost Analysis

This last problem may cause some surprise to efficiency experts as to why any question should be raised as to limiting the inquiry into cost accounting, but the fact is that too much demand upon foremen to separate time or upon material clerks to divide bills will cause undue irritation. This will interfere with the prosecution of the work at any time, and, in these times of varying rates, will lead to no real information. A method of simple cost distribution is entirely within the province of a consulting engineer rather than the office man.

Upon a recent job, representing eight paving contracts, it was considered more essential to divide between labor, material and overhead between the classes of work rather than upon the separate contracts, which would involve merely a divisional distribution.

The Engineer as an Executive

For large companies the function of the consulting engineer may properly be enlarged by his taking the part of the executive. There is no experienced man better able to make good as an executive than a trained engineer, and, on the other hand, being an executive is good training for the engineer, for no man can be a successful adviser who cannot manage a business. I once heard the efficiency expert of the largest manufacturing company in Columbus say that the best quality in any man was "adaptability." The older I grow the more this thought strikes me as being proper. To be able to throw aside preconceived notions and get better ones is only a sign of advancement. In the alliance between the consulting engineer and the hard-headed contractor each gets a better viewpoint of his own worth and limitations. Both the contractor who insists upon doing it the same old way and the engineer who always wants to try something new lack adaptability, and each is handicapped just that much. The sooner each realizes the other's worth the better for both. Like Lincoln's "rat hole," this is worth looking into.

Reinforced Concrete Ships as a Possible Solution of Our Shipping Problem

By Earle P. Press, President of the Concrete Reinforcing and Engineering Company, Cleveland, Ohio

It is interesting to note the rapidity of the growth in general of concrete ship construction caused by the stress of the times. Under ordinary conditions there may have been considerable interest, but the actual progress would have been very slow.

To those of us who are commercially interested and closely following this progress it is surprising to find such a large number of projects, with the result that concrete ship building may almost be classed as an industry. This class of work has especially appealed to contractors who are equipped to undertake concrete construction, but who have very little work on hand of this character, due to present conditions. Many contractors are investigating the opportunity offered.

It has been clearly shown that our transportation facilities have been inadequate, and it is really surprising to us now to

realize what little use we have made of our inland water facilities. In all localities near navigable streams or the great lakes existing transportation companies, or companies about to be formed, appear as live prospects for this business.

In many instances concrete barges can be used to very good advantage. Reinforced concrete barges are comparatively simple in design and easy to build.

Quite a number of concrete ships are being built at this time, most notable of which is the Faith, which was launched in March near San Francisco. We are all familiar, through general publicity, with this launching. However, the mere launching does not indicate finally whether ships of reinforced concrete are successful or not. Actual experience, under heavy sea conditions, is necessary to prove concrete ships successful for ocean service.

It has been definitely pointed out by the Emergency Fleet Corporation that the present emergency calls for ships of large tonnage rather than a larger number of small ships. This policy is responsible for the practical abandonment of the construction of wooden ships.

Unless we can build concrete ships of practically 10,000 tons in a practical manner, reinforced concrete ships are to have very little effect on the shipping problem during the present emergency. It is to be regretted that most of the experimental work in connection with reinforced concrete ships, up to the present date, has been on ships of about 3,500 tons capacity, which will be too small to be decidedly helpful.

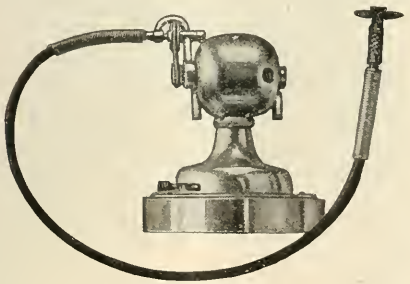
It is not necessary for contractors to apply their efforts to ships of the larger capacity, as it is unwise to build ocean-going ships until our present concrete ships have been subjected to heavy seas. There is a large field, however, for the contractor in smaller ships and barges, which are in no way subjected to the same conditions which confront the ocean-going ship of large size.

It is to be hoped that a larger number of contractors will have the initiative to enter the new industry of reinforced concrete ships.

An Erasing Machine for the Drafting Room

Engineers and others who have observed how easy it is to spoil a costly tracing by rubbing a hole through it with an ink eraser in the hands of a careless operator, will be interested to learn of the new erasing machine that has been placed on the market by Kolesch & Co., 138 Fulton St., New York.

The machine is herewith illustrated. It is driven by a variable speed motor which can be attached to any electric light socket and operates on either direct or alternating current. The flexible shaft which connects the eraser and the motor is 3 ft. long and is attached to a counter-shaft which is driven by a belt, as illustrated.



DRAFTSMAN'S MOTOR-OPERATED ERASING MACHINE.

These erasing machines are sent on 10 days' trial. Of course the circular erasers on which the wear occurs are easily and cheaply replaceable.

Good Practice in Business and Residential Electric Street Lighting

By H. F. Bloomquist, City Engineer, Mankato, Minn.

The importance of attaining a high efficiency in a street lighting system is emphasized by the fact that many municipalities expend as much money for street lighting as they do for maintaining their streets in repair, and all know that street repair work is a large and important item.

Classes of Street Lighting

The following classes of street lighting should be studied separately, namely:

A. Business street lighting.
B. Resident street lighting.
C. Parkway lighting.

In this discussion only electric lighting is considered as it is the only kind used in new systems at this time.

Principles and Features Common to all Systems.

In designing new systems of lighting, special study should be made of the surroundings, the classification and purpose of the lighting. There are, however, some principles and general features that are common to all systems. Among these are:

1. Transmission of energy.
2. Types of lamps used.
3. Placing of lamp units on posts, brackets or suspended.
4. Cost of installation and operation compared to the results obtained.
5. Diffusion of light so as to prevent glare.

Business Street Lighting

The present tendency in business street lighting is to attain a fairly well intensified light from lamps placed on posts on the curbs on both sides of the street. The spacing of posts should not be more than 100 ft. for good distribution. In this class it is desired to illuminate the fronts of buildings as well as the street, and to attain good results a closer spacing with less intense light units is desirable. For curb lights of this class it is necessary to diffuse the light by the use of frosted, opalescent or refracting globes which absorb a certain amount of the light, usually from 10 to 30 per cent, according to the density of globes used and the intensity of the light. To avoid glare, the lamps should be placed about 15 feet above the curb.

Residential Street Lighting

In resident lighting the problem of shade trees enters very strongly as a factor in determining the location of the lights. For lighting the driveway either the bracket or suspended lamp is very efficient, but their appearances are not in harmony with the surroundings and up to date tendency. The shade trees will also prevent the greater part of such light from properly lighting the sidewalks, and dark places along the street. Small units of post light about 10 ft. above the curbs make an attractive method of placing residence street lights if the lower branches of the shade trees are trimmed high. Special attention should be paid to the trimming of shade trees with this point in view. It not only aids the solution of the lighting problem, but also adds to the attractiveness of the street.

Post Lighting

The installation cost of the post lighting is very much more than that of bracket or suspended lamp system, and may not be warranted in all cases.

Parkway lighting may be treated in a manner similar to residential street lighting, with greater spacing of lamps.

In all post systems it is necessary to use underground wire systems, which adds materially to the cost of installation. For underground wiring two general methods are used: the conduit system and the ground or park cable system. For the business section of a city, the writer

strongly recommends the conduit system because of the liability of injury to park cables where excavations are made. Where a conduit system is used it is a comparatively easy matter to take out a section of cable where trouble occurs and draw in another section, but where a park cable is causing trouble from injury or other reasons it is often a long and difficult job to locate and remedy it especially if laid under pavements.

Catalog Reviews

MOTOR ROAD ROLLERS.—Issued by Austin Manufacturing Co., Chicago. 9x12 ins., 64 pages. Illustrates and describes Austin motor road rollers operating on gasoline, kerosene and distillate. Features rollers of macadam and tandem types and gives descriptions of the various machines for road and street scarifying. Designated as Catalog E. Shows numerous interesting and instructive views of this equipment in operation and gives many letters of indorsement received from contractors.

KENTUCKY ROCK ASPHALT.—3¼x5½-in. pamphlet issued by Kentucky Rock Asphalt Co., Louisville, Ky. States advantages of this type of rock surfacing.

CONCRETE MACHINERY.—Issued by the Lakewood Engineering Co., Cleveland, Ohio. 8½x11 ins., 8 pages. Bulletin No. 32. Illustrates and describes the Lakewood Universal mixer.

KISSEL TRUCKS.—Issued by Kissel Motor Car Co., Hartford, Wis. 9x11½ ins., 10 pages. Illustrates and describes the four new Kissel truck models.

ROAD AND HIGHWAY MACHINERY.—Issued by Kinney Manufacturing Co., Boston, Mass. 6x9 ins. Comprises Bulletins A and B, issued in pamphlet form by this company. Pertains to equipment especially designed for handling bituminous material or other similar products used in the construction and maintenance of roads and pavements, with special reference to heaters and pressure distributors, asphalt and tar pumps, steam and gasoline engine driven loading pumps, hand spraying pumps and nozzles, street flushing machines, heating kettles and storage tanks.

MOTOR TRUCK TRAILERS.—Circular issued by Detroit Trailer Co., Inc., Detroit, Mich. Relates to Model D trailer, giving some of the design and construction features, and a brief description, with illustrations of this trailer.

HYDRAULIC MACHINERY.—Issued by Allis-Chalmers Co., Milwaukee, Wis. Bulletin No. 1636-A. 8x10½ ins., 56 pages. Illustrates and describes the full line of hydro-electric power plant machinery and equipment manufactured by this company. Shows drawings of installation details. Gives suggestions on the selection of the correct type of unit. Gives test data and suggestions on the reconstruction of old plants.

SEWAGE DISPOSAL.—Electro-Chemistry Applied to Sewage Disposal, by F. N. Moerk. Copyright by C. P. Landreth, Philadelphia. 6x9 ins., 84 pages. Contains 13 chapters relating to the Bio-chemical Methods of Sewage Disposal, Chlorination, History of Direct Electrolysis of Sewage, The Direct Oxidation Process, Apparatus and Appurtenances of the Direct Oxidation Process, Operation, Results Obtained in Practice, Sludge, Substantiation of the Direct Oxidation Process, Super-Oxidation, Engineering Data, Resume of the Direct Oxidation Process, and Principles of Electro-Chemistry.

CREOSOTED WOOD BLOCK FACTORY FLOORS.—By Lambert T. Ericson, contracting engineer. Issued by Jennison-Wright Company, Toledo, Ohio. 5½x8¾ ins., 8 pages. Relates to causes and prevention of failure in creosoted wood block factory floors. Reprint of paper by Mr. Ericson at 1918 convention of American Wood Preservers' Association.

TARVIA K. P.—Issued by the Barrett Company, New York City. 3½x6 ins., 16 pages. Illustrates and describes each step in patching a road with Tarvia K. P. (kold patch).

Personal Items

Ray S. Blinn is now first assistant engineer of the United States Army Ordnance Department at the Camp Perry Proving Grounds, Fort Clinton, O. He was formerly division engineer on the Illinois Central Railroad, engineer in charge of paving at Columbus, O., city engineer and director of public service at Mt. Vernon, O., city manager of Westerville, O., and consulting engineer for Arthur A. Graham, paving contractor, of Mount Vernon, O.

Virgil G. Marani has been appointed chief engineer of the Gypsum Industries Association, with headquarters in the Harris Trust Building, Chicago. For several years past he has specialized on gypsum products in their application to structural uses. The information he has gathered on this subject will be made available to architects and builders, who are invited to consult, without cost, the Gypsum Industries Association. Mr. Marani graduated from the civil engineering department of Toronto University in 1893. His first engagement was with Mann & White, on canal work for the city of Buffalo. He was next sanitary engineer for Cleveland, O. For 10 years following 1896 he was construction engineer for the Cleveland Gas, Light and Coke Company. He then opened private offices in Cleveland and had supervision of the construction of the Cuyahoga County Courthouse Building, a $5,000,000 job. In 1910 and 1911 he was building commissioner of Cleveland, and revised its building code. In 1912 he had charge of the erection of floors and fire-proofing for various large buildings in Cleveland. For the last five years he has been consulting engineer for the United States Gypsum Company, being also in charge of their information and promotion departments.

George A. Johnson, consulting hydraulic and sanitary engineer, New York City, has accepted a commission as major in the office of the Construction Division, War Department, Washington, D. C.

W. G. Goodwin has been appointed chief engineer and superintendent of the Kansas City, Mo., water department, to succeed Burton Lowther.

Roy G. Buck has resigned his position as assistant engineer with the Indianapolis Water Company, and has taken a position with C. H. Hurd, consulting engineer. Merchants Bank Building, Indianapolis, Ind.

John M. Goodell has been appointed consulting engineer of the United States Office of Public Roads and Rural Engineering. He will represent the Office of Public Roads and Rural Engineering on the United States Highway Council.

Chas. E. Ashburner, who has been city manager of Springfield, O., since January 1, 1914, will become city manager of Norfolk, Va., on September 1. He is well known as the first of the city managers. He was city manager at Staunton, Va., from April, 1908, to July, 1911. From then until he went to Springfield, O., as city manager, he was in railway work.

Lieut. John W. Kelsey has been appointed superintendent of the Bureau of Water at St. Paul, Minn. The appointment is the result of a competitive civil service examination. Lieut. Kelsey is now on duty at Camp McClellan, Ala., and the position of superintendent of the St. Paul Bureau of Water will be held open for him until his return. He succeeds G. O. House, who resigned the office to become superintendent of the St. Paul City Railway Lines.

Wilbur A. Ginn, Sanford, Fla., was employed by the Board of Public Works of Sarasota, Fla., preliminary to taking over the Franchise Company's lighting plant. Mr. Ginn's studies contemplated the consolidation of the plants under new powers with improvements and extensions. The new work will comprise an up-to-date power plant, utilizing the most economical war fuel. Water and sewer mains will be extended to insure a general distribution of the city water to accommodate the fast growing suburban districts.

EDITORIALS

For a Supreme Federal Highway Commission

The need for a supreme federal highway commission, with a personnel fully informed on the economics of highway transportation, is imperative. The men appointed to membership on this commission must, first of all, believe in the military and commercial value of hard-surfaced roads; they must think roads, they must advocate roads, they must realize that roads are essential. With such a body to lead and correlate all road planning agencies, of whatever nature, we shall secure quickly a rational plan for a comprehensive system of improved highways throughout the entire country. Under the leadership of this supreme federal highway commission an informed public opinion will develop pressure which will insure the prompt construction of the roads of primary importance, and the early construction of roads of secondary military and commercial value.

Every close student of the American highway problem now realizes that without well defined leadership of this character, the good roads movement will continue to bog down like a motor truck carrying urgently needed war materials over a mud road. For a while last spring it seemed that the United States Office of Public Roads and Rural Engineering might rise to the occasion and assume forceful leadership in all highway matters, but this hope was disappointed. The activities of that office have their statutory limitations. Again, many hailed the formation of the United States Highways Council as an indication of a change in the attitude of official Washington toward road construction in war time. This is not the case. The creation of this council merely centralized the agencies which have been imposing restrictions on highway improvements. Before the formation of this council it was necessary to peddle a road improvement project from one department to another, thus consuming much time and energy. A project now goes to the council where, theoretically at least, it receives final disposal on behalf of the various department boards, bureaus, councils, committees, etc., who previously gave it attention separately. This is an improvement in the highways situation, without doubt, but at best it is no more than better co-ordination of the various restrictive agencies. It should be definitely understood that the United States Highways Council was not organized for the vigorous prosecution of highway improvements. It is, and always has been, a restrictive body and presumably it will remain a restrictive body until the fundamental policy toward road improvement is changed. It is only another judge. It is not an advocate. The situation demands a supreme advocate of highway improvement to speed up the rational and immediate development of highway transportation, involving the formulation of a comprehensive plan for a system of trunk and feeder highways and the construction of these highways as soon as possible.

What is needed, and needed most imperatively, is the immediate creation of a supreme federal highway commission that shall rank with the Railway Administration and the Emergency Fleet Corporation. Road building must be prosecuted with the enlightened vigor being shown in shipbuilding.

Highway transportation is basic. What is eventually shipped overseas must first be hauled over the railroads and to the railroads, from the point of production, over the highways. Take the case of food which, we are assured, will win the war. Farmers are straining every nerve to increase the production of food, yet not one single thing has been done in the way of road improvement to aid the farmers in distributing what they produce. Much food is interned on the farm because of poor road conditions in the natural marketing season. At this instant there are many hundreds of thousands of bushels of 1917 corn in the cribs of Illinois farmers. Last winter and spring when the farmers had time to haul this corn to town they couldn't because of the impassable condition of the mud roads of this tremendously wealthy state. Now what is the immediate prospect for road improvement in Illinois? Precisely this: At the general election in November the people of the state will vote on the issuance of $60,000,000 of bonds to defray the cost of a state-wide system of durable, hard-surfaced roadways upon the public highways of the state, comprising 46 separate and distinct intercity routes. But that is but the rotation of the legal machinery, long since set in motion. The governor of the state has urged the approval of the bond issue but has made clear his intention to defer construction of these urgently needed roads until after the war! The inconsistency of the official attitude towards road improvement work in war time was never better or more unfortunately illustrated.

The supreme federal highway commission should be created by Congress at once either on its own initiative or that of the President. This commission must be granted broad powers and adequate funds. It should be so constituted that it can make a quick survey of the immediate and prospective requirements of highway transportation and should be given mandatory powers so that it can order federal, state, county and township road funds expended on the improvement of prescribed highways which shall link together to form a comprehensive national road system. The commission should be in position to augment local funds where necessary to speed up the construction of local roads.

After a thorough trial of the economic feasibility of motor trucking mailable merchandise over the highways the postoffice official in charge of this work gives it his unqualified endorsement on the broad grounds of giving the producer a better and steadier market and of bringing to the consumer produce of an improved quality at a decreased cost. Thus the federal government itself has demonstrated the great value of highway transportation in war time. A bill is now pending in Congress to authorize the expenditure of 50 per cent. of the profits of the motor parcel post service for road repairs and new construction on the routes traversed. This is convincing evidence of the value of highway transportation in war time, and it is submitted by a major department of the fed-

eral government. But this new federal endorsement of highways is only heaping measure; for many months the national government, through some of its departments, has been falling back on the highways to make good the inadequate service obtainable from the railways. At the same time other federal agencies have hampered road construction at every opportunity. Sometimes road work has been forbidden; at other times it has merely been made impossible through one or more restrictive orders.

This incongruous condition has existed much too long. Let us have done with this off again, on again, gone again, Finnegan method of regulating highway transportation.

The bankers on the Capital Issues Committee are throttling highway transportation. They appear to think that the moment a dollar is spent for road building it goes permanently out of circulation, that its usefulness has terminated. This view indicates a total lack of understanding of the use and power of money. But these gentlemen are obdurate; their minds are firmly made up and, unfortunately, they are made up in the conclusion that road building in war time is a non-essential. The individual can scarcely hope to change this opinion even if he is permitted the opportunity.

In general, it may be concluded that no adequate relief from this unwise restrictive policy can come from existing government agencies. The logic of the situation clearly calls for the creation of a federal highway commission of such standing and with such powers that it can meet on equal footing the obstructionists of highway transportation and convince them of the great disservice they are rendering the nation in suppressing highway improvements.

Such a commission, armed with its meritorious cause and backed by an enlightened public opinion, will overcome all resistance and will build the roads we need; roads that we need now and will need for an indefinite period in the future.

Are Good Roads Essential?

If any considerable headway in road improvement is to be made during the war it is first necessary to convince official Washington that good roads are essential. The question is not one of money, as many suppose, but entirely one of opinion, so far as the Capital Issues Committee is concerned. It is well to understand this point.

Recently a worker in the construction field discussed with an Ohio banker the attitude of the Capital Issues Committee toward highway improvement during the war. This banker presented the view of the bankers. In defense of their stand he made the statement that if his best customer were to come into the bank that day and ask for $100,000, the bank would refuse the loan. He admitted that it could be secured from the Federal Reserve Bank upon a day or two notice, discounting the bank's own note. He finally admitted that if official Washington were to declare road improvement an essential, the funds would be forthcoming without restriction. This means one thing, and one thing only: Funds are denied for road improvement purposes, not because there are not funds enough, but merely because road improvement has been declared non-essential, and therefore is restricted financially. Note the distinction in this banker's explanation.

Workers in the construction field can depend upon it that if they don't come to the front in their own behalf they will continue to wear the non-essential label. From the other fellow's standpoint your business is generally regarded as a non-essential, if not an incubus. If he argues that your work is unimportant and you say nothing in defense of it, his point will be sustained. Only a few industries, like farming and coal mining, are essential beyond dispute; only a few businesses, like baseball, are clearly non-essential. All other businesses fall somewhere between these extremes. They will be classed as essential or non-essential, depending very largely upon the persistency and skill with which their just claims to the right of existence are presented.

It is probably unnecessary to argue that dependable highways are essential in war times, so far as our readers are concerned. If any reader who has successfully "reduced the art of self-abnegation to a science," and is unhappy unless renouncing his personal and constitutional rights, has any lingering doubt on this point, let him read the letter to the editor from Fourth Assistant Postmaster General Blakslee, published in the Motor Truck section of this issue.

But the question is not one of individual interest, but of individual duty. For months this journal has been urging its readers to use their influence to prevent our national leaders continuing their mistaken attitude on the highway question. We have asserted in every issue for months that official Washington fails to appreciate the economic importance of good, usable highways, and have, at the risk of being considered unpatriotic, urged our readers to exert all their influence to change the official opinion that such highways are now among the non-essentials.

These days the newspapers are carrying glowing prophecies of what this nation can do with the 25,000,000 tons of merchant shipping it will have available for commerce at the end of the war. We will have the ships, don't doubt it, and we will have cargoes, but it is going to be an economic impossibility to bring the cargoes to the ships unless our roads are made passable twelve months in the year instead of three.

Next to winning the war the thing the American people most desire is to see the cost of living reduced. The improvement of roads, making possible the hauling of mailable merchandise in motor trucks over the highways, in all seasons, will greatly reduce the cost of living. This consideration may yet so affect the national morale as to be the deciding factor in the war itself. Judged by military, social and economic standards, good roads are essential.

Force Account Work on Illinois Roads

The Division of Highways of the Illinois Department of Public Works and Buildings now has under force account construction two pieces of road work in Iroquois county, one in Kankakee county and two on the Lincoln Highway, one of the latter being at Chicago Heights and one near Malta. The Division of Highways very wisely decided to do this work by force account because the contractors' bids received were considered too high. When the contractors bid on these jobs some weeks ago they naturally made an allowance in their bids for the risk due to car and labor shortage, and other uncertain conditions due to the war. Consequently, it was decided to do the work by force account, the state thereby taking all the risk due to war conditions.

Construction of Water and Sewerage Systems for the Cities of Salto, Paysandu and Mercedes, Republic of Uruguay, South America

Municipal Improvements Costing $5,000,000—Plans Revised by American Engineers and Works Constructed by American Contractors Using American Materials and Methods.

By G. E. Hines, Chief Mechanical Engineer, Ulen Contracting Co., Chicago

It may surprise not a few of us to know that the Republic of Uruguay (La Republica Oriental del Uruguay) is a progressive, wide-awake republic, fully recognizing the advantages accruing from modern sanitary and municipal improvements. We should divorce from our minds the thought that this republic is infested with Indians, crocodiles, boa constrictors and revolutions. On the contrary, the country is inhabited by white people, highly civilized and intelligent, progressive, and differing only slightly from ourselves, and that chiefly in the language spoken.

Montevideo, the capital and largest city of the republic, with a population of about 400,000 people, is a modern city in every sense of the word, enjoying the benefits of a modern storm and sanitary sewerage system, water works, street railways, electric lights and gas. In municipal improvements, children's playgrounds, cleanliness, civic pride, and in the maintenance of law and order, it sets an example that many of our North American cities would do well to copy.

Geographically speaking, the Republic of Uruguay, in the Southern Hemisphere, lies between the same degrees of latitude as the State of Mississippi. The United States of Brazil forms its northern boundary, while the Atlantic ocean and its estuary, the River Plate, form the eastern and southern boundaries. The River Uruguay, which divides Uruguay from the Republic of Argentine, forms the western boundary, and as well supplies the full name of the republic, due to the fact that it lies entirely east of the river.

The distance from New York City by the shortest water route is some 7,500 miles and the time required by the passenger steamers is on an average about 21 days. The east coast of Uruguay is about 20 degrees east of New York City.

Political and Industrial Characteristics

The area of Uruguay is approximately 72,000 square miles, or slightly larger than the State of North Dakota. The population, as given by the 1908 census, was 1,042,186.

The Republic of Uruguay is divided into nineteen "departamentos" or states. The form of government is very similar to that of the United States of America. The President is elected for a period of six years, while the Governors of the various states are appointed by the President.

The country as a whole is not unlike that of parts of the United States. The land is a rolling plain, with very few trees, is well watered and particularly well adapted to the raising of live stock, which is the chief source of the country's wealth. Cattle and sheep thrive and fatten on the grass alone, no grain being required.

In addition to raising stock, certain sections are devoted to farming. The average annual production of wheat, amounting to approximately 9,000,000 bushels, as well as corn and alfalfa, contribute greatly to the country's wealth. The northern part of the republic is well adapted to citrus groves, while in the southern part are many vineyards.

One of the chief industries is the packing plants, chiefly owned by the various packing companies of the United States. There are several small factories for the manufacturing of shoes, harness, hats and other similar articles, but for the most part they depend upon importations. Fuel is very scarce.

The climate is very agreeable and healthful. The seasons are the reverse of those of the United States. The minimum temperature in the winter time is about 31 degrees F., while in the summer the maximum is about 90 degrees F. In the northern part it is much warmer in summer and not so cold in winter.

The language spoken is Spanish. The people are of a mixture of Spanish and Italian blood. The census of 1908 showed that about 18 per cent of the population were foreigners, of which about one-third were Italians, and the balance made up of Spaniards, Brazilians, Argentinians and other nationalities.

The monetary standard is the gold peso, worth $1.035 U. S. The total wealth of Uruguay is estimated at $2,000,000,000, of which $1,410,000,000 is invested in cattle raising or agriculture.

There are nine railway companies, operating a total of 1,630 miles of track in Uruguay, representing a capitalization on December 20, 1916, of $85,000,000. All the railroad companies are English.

History of the Work

By a special law enacted by the Republic of Uruguay it was decided to employ engineers to prepare plans, specifications, estimates and reports with reference to providing the cities

VIEWS ON WATER AND SEWERAGE WORKS BUILT IN URUGUAY BY AMERICAN CONTRACTORS.
Cement Pipe Made by Ulen Contracting Co., at Paysandu—Unloading Cast Iron Water Pipe From the "Edon" at Montevideo.

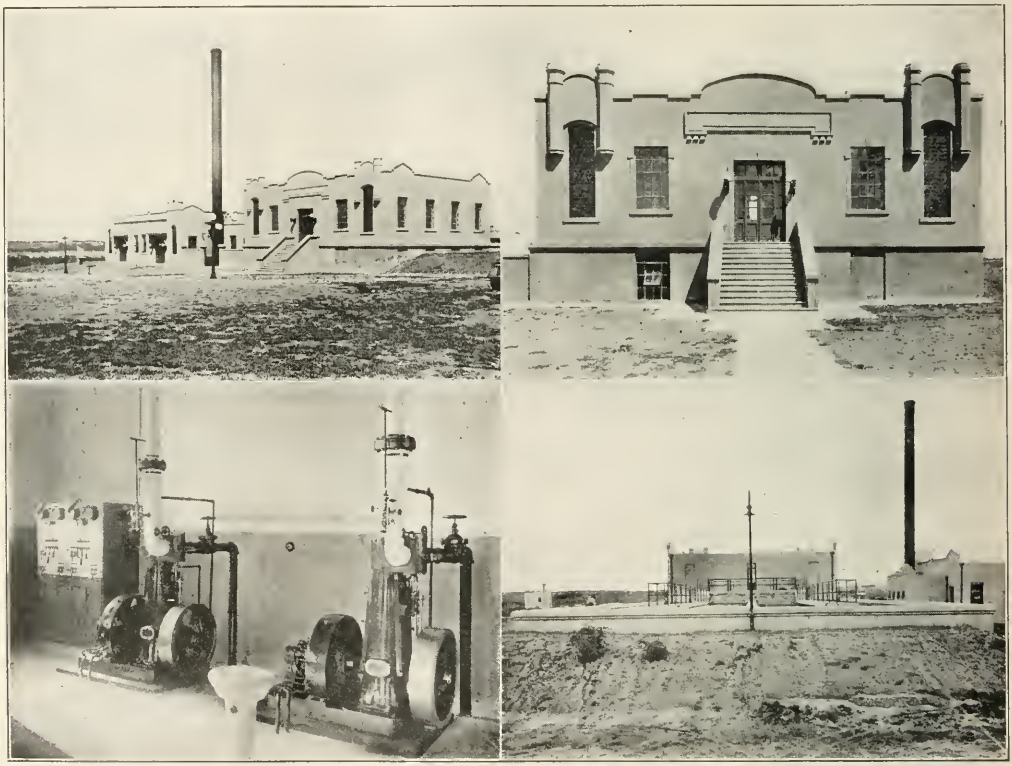
of Salto, Paysandu and Mercedes with water and sewers. A group of eminent French engineers were given a contract for this engineering work. Complete plans and specifications were prepared covering the principal cities in the republic. These plans were finished and approved by the Minister of Public Works in the year 1911.

A law was passed authorizing the President to enter into contract for the construction of the water and sewer systems as covered by the plans and specifications. Several tentative proposals by various contractors were made, but nothing definite was decided upon until 1915.

During the latter part of the year 1915 John R. Ulen, C. M. Bounell, vice presidents, and E. G. Trueheart, chief engineer, all of the Ulen Contracting Co., went to Uruguay and immediately took up with the Uruguayan officials the proposed works. A careful and thorough investigation of the company was made by the Uruguayan government, with the result that a contract was entered into on February 2, 1916, for building a complete water and sewer system for the cities of Salto, Paysandu and Mercedes.

By the terms of the contract the company agreed to take Uruguayan government bonds in payment, the work to be started within six months from the date of signing the contract and completed within three and one-half years. A clause, however, was inserted in the contract providing that if either the United States or the Republic of Uruguay should become involved in an international war or a civil war, the contract time was to be extended during the period of the war. A bond issue of 5,022,000 pesos, or $5,197,770 U. S., was authorized by the Uruguayan government for the work.

On March 27, 1916, the first contingent of the Ulen Contracting Company arrived in Montevideo. The work in Salto was started July 27, 1916, and was accepted by the government December 1, 1917. The work in Paysandu was started in October, 1916, and accepted in April, 1918, while the work in Mercedes was started in November, 1916, and accepted in January, 1918. From the time the first work was started until the last job was finished and accepted it required just half the time allowed for completion by the contract. This work was carried on after the United States of America entered the war and the company did not exercise its prerogative to stop work, as set forth in the contract, but continued the work even though prices of material and freight rates increased in some instances over 200 per cent.



VIEWS OF WATER WORKS DESIGNED AND BUILT BY AMERICANS, USING AMERICAN MACHINERY AND MATERIALS, IN URUGUAY, SOUTH AMERICA.

Top Row: Filter Building and Power House. Front View of Filter Building. Bottom Row: Lighting Sets for Lighting Buildings and Grounds. Settling Basins.

This attitude of continuing the work and finishing it during the war saved the Uruguayan government much money, and also increased the popularity of the Ulen Contracting Company with the Uruguayan officials.

Scope of the Work

According to the specifications, the population of the three cities in 1908 which were to be served with water and sewers was as follows: Salto, 23,000; Paysandu, 21,000; Mercedes, 15,700.

The water distribution systems, including the storage res-

ervoirs and discharge and equalizing mains, were designed for double the above populations. The sewers were likewise designed on the same basis.

The pumping plants and water purification systems were designed for the population as given, but the pumping period was 12 hours instead of 24 hours, so that by operating the plant 24 hours double the population could be served. All pumping plant equipment was in duplicate, so that loss of time due to breakage and shutdowns was reduced to a minimum.

The sewer system was the combined plan, designed to take care of the storm water as well as the sewage from houses, etc. The only city requiring, in the estimation of the government engineer, a sewage purification plant was Mercedes.

The source of water supply for Salto and Paysandu was the Uruguay river. Mercedes receives its water from the Negro river. These same rivers served also as the disposal point for the sewage. The water intake in every case was located from 2 to 3 miles above the point of the discharge from the outfall sewer. All pipe in the water distribution system was cast iron, while the sewer pipe was to be either vitrified clay or cement.

The water consumption per inhabitant per day of 24 hours was fixed at 150 liters, or about 40 gals. Ample allowance in addition to this was made for flush tanks and other uses. On this basis the daily water consumption for Salto was estimated at 2,221,000 gals. and for Paysandu and Mercedes 2,113,500 gals. each.

The water storage reservoirs for Salto and Paysandu were two reinforced concrete tanks on reinforced concrete towers, while for Mercedes, which was favored by a hill at the edge of the city, a plain concrete, rectangular reservoir, divided into two parts, was specified.

The capacities of the storage reservoirs were as follows: Salto, 581,000 gals.; Paysandu, 515,000 gals.; Mercedes, 1,016,000 gals.

The type of water purification plant specified was a combination of the slow sand and rapid sand type filters. Large settling basins were provided and so arranged that the water could be dosed with chemicals. The water passed over a series of aerating cascades from the settling basins to the prefilters. These prefilters were very similar to the rapid sand type, excepting that the rate of filtration was much higher than the standard adopted by the engineers of the United States. After passing through the prefilters the water flowed through a flume to the slow sand filters and thence to the clear water reservoir. The loss in head, i. e., the difference between maximum water levels in the settling basins and clear water reservoir, was 20 ft. 8 ins.

The type of pumping machinery specified was belted centrifugal, low-service pumps, and belted triplex, high-service pumps, all driven from a jackshaft. The prime movers were to be vertical, compound belted steam engines. The boilers were to be of the multitubular return tube type, each provided with a feed-water heater, to be located in the gas passages, similar to fuel economizers.

The total pumping heads, including low-service pumps and friction, were as follows: Salto, 250 ft.; Paysandu, 260 ft.; Mercedes, 255 ft.

The size of the discharge mains from the power house to the storage reservoirs was 20 ins. for Salto and Paysandu and 18 ins. for Mercedes. Between the two storage reservoirs for Salto and Paysandu there was a 24-in. equalizing main specified, in addition to a 24-in. line from each tank, which fed the distribution system. There was only one 20-in. line feeding the distribution system at Mercedes.

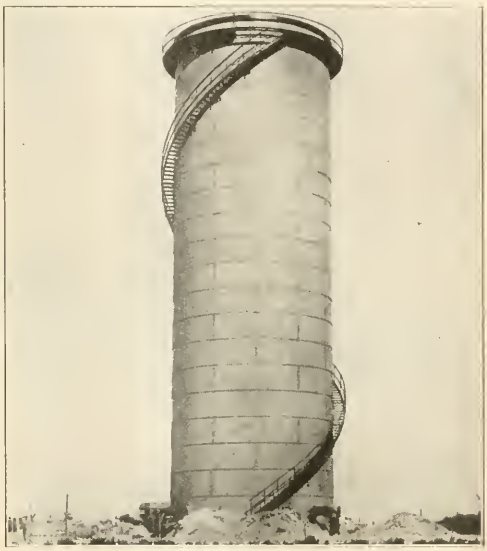
Owing to the difference in grades in the three cities, the size of the outfall sewers varied. The types of outfall sewers specified for all three cities were egg-shaped and the sizes were as follows: Salto, 5 ft. 5 ins. by 3 ft. 7 ins.; Paysandu, 6 ft. 11 ins. by 4 ft. 7 ins.; Mercedes, 5 ft. 11 ins. by 4 ft.

There were three types of sewers specified. The pipe sewers varied in size from 7⅞ ins. to 21½ ins.; the circular monolithic varied in size from 23½ ins. to 3 ft. 3 ins., while the egg-shape varied in size from 4 ft. 5 ins. by 2 ft. 11 ins. to 6 ft. 11 ins. by 4 ft. 7 ins. All monolithic and egg-shaped sewers were to be built of plain concrete.

The sizes of the water mains varied from the 3-in. service lines to 24 ins. Ample provision for fire hydrants, public service hydrants, valves and blow-off valves were made in the distribution system.

Changes in Plans and Specifications

Inasmuch as the plans and specifications were drawn with a view of utilizing European-made materials and equipment and European methods of construction, it was deemed advisable to ask the Uruguayan government to approve plans such that North American materials and equipment and methods of construction could be utilized. Accordingly plans and specifications were prepared by the engineers of the Ulen Contracting Company and submitted to the government officials. These were all approved and the work built in accordance therewith.



VIEW OF THE LARGER OF TWO STANDPIPES AT PAYSANDU, URUGUAY.

The most vital changes were as follows:

(a) Substituting American-made cast iron pipe for European-made and changing the sizes from the metric system to the nearest size in inches.

(b) Replacing all 3-in. cast iron service lines with 4-in.

(c) Changing the reinforced concrete storage reservoirs on concrete towers to standard steel standpipes.

(d) In lieu of plastering the interior of monolithic and egg-shaped sewers, steel forms were used instead of wood forms.

(e) Instead of belt-driven equipment for the pumping plants, changed to direct driven units, such as steam turbine driven centrifugal low-service pumps and triple expansion direct acting high-service pumps.

(f) A complete change in the water purification system, utilizing the modern North American mechanical filters.

(g) Change in all buildings from corrugated iron on steel frame work to brick and reinforced concrete.

(h) Revision of the plans covering intake, utilizing an intake well with strainers, check and gate valves, instead of timber cribs.

(i) Redesign of sewer system at Mercedes, eliminating

sewage purification plant and carrying outfall farther dc and well out into the channel of the river.

(j) Substituting wherever possible reinforced concrete for plain concrete.

(k) No vitrified pipe is manufactured in South America, and owing to excessive transportation rates from U. S. points concrete pipe was adopted.

(l) Changing from European-made flush tank siphons to the American type, as well as changes in the type of manhole, flush tank and catchbasin castings.

With the changes as outlined above, the plants as built are purely American, as all material that entered into the construction of the plants was manufactured in the United States, with the exception of the cement, which was manufactured in Uruguay.

Transportation

One of the largest and most vital questions which presented itself was the transportation of materials from the United States to the job. Practically all of the shipping had been taken over by the Allied governments for war purposes, and freight rates were climbing at such an alarming rate that the company purchased the "Alice M. Colburn," a four-masted schooner.

The amount of material that it was necessary to ship from the United States was some 16,000 tons. Three other vessels were chartered, and in addition several hundred tons were shipped on other vessels plying between New York and Montevideo.

The sailing vessels required from 57 to 86 days to make the voyage from Savannah, Ga., to Montevideo. The "Alice M. Colburn" made two round trips, each trip requiring something like nine months. The average time required by the steamers from New York was about 25 days.

On her first voyage the "Alice M. Colburn" was taken up the Uruguay river and discharged at Paysandu. All other shipments were unloaded at the modern docks at Montevideo and were sent to the various jobs by railroad and river boats. All three cities were favorably located for either railroad or water transportation; however, by either route the tariff was sufficiently high as compared to transportation in the United States.

The total weight of all material used on the works was a little in excess of 100,000 tons, so that the transportation problem was one of the largest handled and at the same time one of the largest items of expense.

Construction

Each job was handled independently of the others, and a complete organization was built up in each city. Montevideo was selected for the general office, and all three jobs were directed from that office.

The heads of the various departments were men especially selected from the United States. The superintendent of construction on each job, as well as the men in charge of the office, the master mechanic, the resident engineer and several foremen were all American men who had been with the company for years. The men soon learned to "get by" with the Spanish language, and everything moved along like a well-oiled piece of machinery.

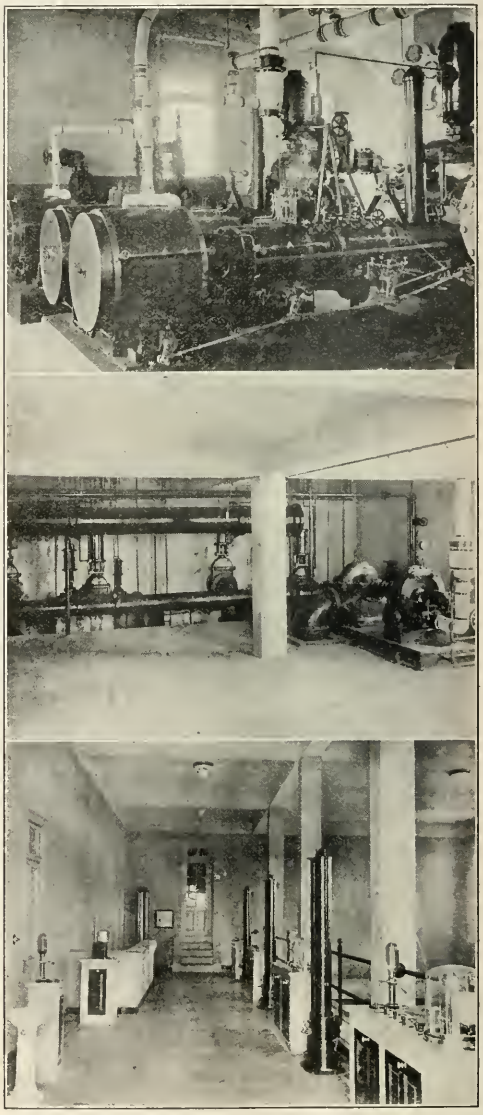
Cement Pipe Plant

One of the most important items of the entire construction plant was a cement sewer pipe machine made especially for the company. This machine caused more consternation and favorable comment on the part of the officials than any other piece of equipment on the job. The cement pipe plant was used first in making the pipe for Salto, then dismantled and moved to Paysandu, and then moved to Mercedes. More than 80 miles of cement pipe was made for all three cities in a little less than 8 months of actual working time.

The total length of all sewer lines, including house connections, main collectors and outfall sewers installed, was 133,403 ft. for Salto, 190,965 ft. for Paysandu and 145,223 ft. for Mercedes. The total number of barrels of cement used on all three jobs in the sewer system was 57,204.

Siphons

On the Salto job four double-pipe siphons were built for crossing several creeks within the city. The size of each pipe was 32-in. Class A, cast iron. At the entrance to each siphon was constructed a large sand or grit chamber and a settling tank. The part of the siphon which was submerged was imbedded in concrete, and on either side of the creek were con-



VIEWS OF PUMPING AND FILTERING EQUIPMENT OF WATER WORKS AT SALTO, URUGUAY.

View of High Service Pumps. Filter Pipe Gallery and Wash Water Pumps. Operating Gallery of Filter Plant.

structed large manholes, in which were located clean-out tees provided with a cover which could be readily removed and yet were water-tight. In each cover was provided a valve such that the sewage in the siphons above the clean-out tees could be drained down so that the manholes would not be flooded when the cover was removed. At the entrance to each siphon line there was also provided a sluice gate and the grit and settling chamber was divided into two parts, such that the sewage could be by-passed to either siphon pipe. There was one siphon in the Mercedes system similar to this.

The Sewerage Systems

Along the main collectors and outfall sewers on all three jobs were placed "vertederos," or storm-water overflows. These were so arranged that when the volume of the storm water reached the calculated carrying capacity of the sewer, the surplus would pass over weirs placed along the sewer main and would be diverted through a pipe directly to the river or other water channel. There were seven "vertederos" in the Salto sewer system, four in Paysandu and two in Mercedes.

The Mercedes outfall sewer was carried well out into the Negro river channel. At Paysandu the topography and other conditions were such that it was not necessary to prolong the sewer, so that there was constructed 3,346 ft. of paved open channel. The main outfall discharges into a sand chamber

Water Distribution Systems

The water distribution systems for all three cities consist of standard American-made cast iron pipe varying in size from 4-in. to 24-in. for Salto and Paysandu and from 4-in. to 20-in. in Mercedes. The pipe was all laid in the usual manner with bell and spigot joints. There are very few dead ends, as the system was laid out such that the entire district to be served is surrounded with the larger sized pipes. This district was then divided up into squares of about 16 to 20 blocks by smaller sized pipes, and the squares were then covered by ths 4-in. service pipes. Ample valves were provided for cutting off any desired section of the system.

The total length of the water lines laid in Salto, including the discharge main from the power house to the standpipes, as well as the equalizing lines between the standpipes, is 126,913 ft., while for Paysandu the length is 174,316 ft. As stated before, there is only one reservoir at Mercedes, and consequently no equalizing line, yet the total length of water pipe was 140,871 ft. On a tonnage basis there was more pipe laid in Salto than in Paysandu and more in Paysandu than in Mercedes. Paysandu required more pipe in length than either Salto or Mercedes, due to the fact that the city is less densely settled and covers much more territory than either of the other two cities.

VIEWS OF WATER AND SEWERAGE WORKS AT SALTO, URUGUAY, SOUTH AMERICA.
Stormwater Overflow Outlet—Stormwater Overflow From Sewer—Water Intake for Salto is at the Salto Chico Falls.

similar to that described for the siphons, and from there the sewage flows into the open channel. For the discharge from the "vertederos" at Salto it was necessary to construct 404 ft. of open channel work.

Flush Tanks and Manholes

On all three jobs four different sizes of flush tanks were constructed, varying in design only as to their capacity. The capacities were determined by the length and size of the lateral which was to be flushed. The capacities were 133 gals. for the smallest size to 532 gals. for the largest size. The other two sizes were 266 and 399 gals., respectively.

Two types of manholes were installed. Type No. 1 was installed over the pipe sewers and the smaller sizes of monolithic sewers, while type No. 2 was installed on the egg-shaped and large monolithic sewers.

The sewer system as designed by the European engineers was the zigzag system—that is, owing to the absence of alleys, the sewers are all laid in the center of the streets and follow as nearly as possible the contour lines. Therefore, at street intersections a manhole may have two sewers which will either pass over one another at different grades or will make a turn at different elevations, and in some instances the elevations are the same. For this reason it was necessary to use two different types of manholes.

All catchbasins were provided with 8-in. connections, which discharged directly into the manholes at the street intersections. The catchbasins were not provided with traps, as it was considered that in a semi-tropical country the odors from the matter contained in the traps would be more offensive than those emanating from the sewers proper.

Hydrants

Fire hydrants of the flush type were installed at every street intersection in the business districts. In the residential districts they were spaced according to the density of population. In the outlying districts there were also installed so-called public service post hydrants. These hydrants are massive cast iron ornamental posts, each provided with a ¾-in. self-closing compression bib cock or faucet and a 2½-in. fire hose connection, and are for the use of the poorer classes, who cannot afford running water in their homes.

Over a half million pounds of lead was used in laying the pipes and setting valves and hydrants.

Water Storage

The water storage reservoirs for Salto consist of two steel standpipes, each 100 ft. high. They are provided with a spiral steel stairway on the outside, which leads to a balcony at the top. The standpipes are provided with a conical steel roof with a steel door.

The diameter of the larger Salto standpipe is 32 ft. 8 ins., while the smaller standpipe has a diameter of 30 ft. The total effective water storage is 1,152,000 gals. for the two standpipes.

The standpipes for Paysandu are the same height as those at Salto. The larger is the same size as the large standpipe at Salto, while the diameter of the smaller one is 25 ft. The total combined available storage is 985,000 gals.

The storage reservoir at Mercedes was built, as originally planned, of concrete on top of a hill. The reservoir is rectangular in shape, with a division wall dividing it into two equal compartments and covered with a reinforced concrete roof.

supported on cast iron columns. The reservoir was buried two-thirds of its depth and the excavated material was used in banking around and covering it. The total water storage is 1,016,000 gals.

The water works intake for the low-service pumps consists of a rectangular concrete chamber 17 ft. 6 ins. deep. In this chamber is located an entrance gate valve, a twin trash strainer, check valve and by-pass valve, also a sump valve for emptying the chamber in case it is flooded. The chambers are waterproof, so that access can be had at all times to the contained apparatus, excepting, of course, during extremely high water.

All valves in the chamber are below minimum low water, while the suction line leading out into the river is totally submerged at all times. The water flows by gravity to the check valve within the chamber, and from there the pumps pick it up and discharge it to the mixing chambers of the settling basins. The intake chamber is covered and provided with a large steel door. All valves can be operated from the roof of the chamber, while it is only necessary to enter the chamber to clean out the trash strainer.

THE SEWAGE PASSES FROM SEWER THROUGH SETTLING TANK AND OPEN CHANNEL AT PAYSANDU TO RIVER BEYOND.

Water Purification Works

The settling basins, power houses, filters and filter buildings and clear-water wells, as constructed for all three cities, are the same size, as there was such a small difference in the capacities specified that it was more economical to make all three plants duplicates of each other than to alter the plans to fit the requirements. For instance, the capacity in gallons per minute was 1,540 for Salto and 1,470 for Paysandu and Mercedes. All three plants were built on the basis of the requirements for Salto, and thus by this change the government profited to the extent of increased surplus capacities for Paysandu and Mercedes.

The settling basins are constructed of reinforced concrete, divided into two parts, each half provided with a baffle wall. A mixing chamber designed for a 30-minute mixing period is a part of the basins. The basins, including the mixing chambers, are designed for a six-hour sedimentation period, and the results obtained with the river at various stages were absolutely satisfactory. During the ordinary stage of the Uruguay river and Negro river there is very little turbidity, while during the flood stages the rivers are not unlike the Missouri and Mississippi rivers.

The filter plant was built adjacent to the settling basins, one wall of the settling basins serving as a common wall for the filter plant. There are four filter units, each unit having an area of 195 sq. ft. The beds were constructed of reinforced concrete in the usual manner.

The building housing the filters, in plan 50 ft. by 55 ft., is constructed of brick, plastered inside and out. The roof is of reinforced concrete, supported on concrete columns. The filters, operating room, office, laboratory and chemical room occupy the first floor, while the pipe gallery and chemical storage constitutes the basement. Beneath the pipe gallery is a supplementary clear-water flume having a capacity of 26,000 gals., from which the wash-water pump receives its supply for washing the filters. This flume is connected to the clear-water well by means of a 20-in. cast iron pipe.

Filter Equipment

The filter equipment is the most modern obtainable. The operating tables are of marble, all valves hydraulically operated, automatic proportional chemical feed, the Earl improved type rate controllers, with master control, sample pumps and clear-water well depth gage.

The clear-water wells are built of reinforced concrete, with a reinforced concrete roof. The diameter of each is 50 ft., by 19 ft. deep. The roof projects about 18 ins. above the surface of the ground in each case, and is provided with a large steel door. Each clear-water well is provided with an overflow, the outer end of which is provided with a tide flap valve contained in a concrete box. The available water storage capacity of each clear-water well is 210,000 gals.

Power House

The power house, in plan 67 ft. by 52 ft., with a coal bunker 29 ft. by 12 ft., is the same type of construction as the filter house. In addition to the coal bunkers, the power house is divided into a boiler room, pump room, machine shop and bath room. In one corner of the pump room is a circular concrete pump pit 20 ft. in diameter, provided with a circular steel stairway. The depth of the pump pit for Salto was 25 ft., for Paysandu 14 ft. 6 ins. and for Mercedes 19 ft., these depths being controlled by the topography and flood stages of the river. The maximum low-service pump suction lifts are exactly the same for all three plants, while the length of the suction lines varies in accordance with the plant's location relative to the river.

THE URUGUAYAN LABORER.
Hot Weather (January) Costume—What a Gaucho Laborer Wears.

Power Plant Machinery

The power plant machinery for each city is in duplicate or divided into two groups, and consists of two 150-h.p. high-pressure, return tubular boilers, set in a steel casing. Each bat-

tery of boilers is provided with a horizontal steel breeching connected to a steel stack 4 ft. in diameter by 80 ft. in height. In each plant there is a 300-h.p. open-exhaust boiler feed-water heater and two 5¼x3½x5 boiler feed pumps. The high-service pumps consist of two horizontal, triple-expansion, direct-acting, condensing, pumping engines, while the low-service pumps are the split-case double-suction centrifugal type, directly connected through herringbone reducing gears to condensing steam turbines. The high-service and low-service pumps exhaust into 300-sq.ft. surface condensers, each provided with a direct-acting combined air and circulating pump. In each power house, for lighting the buildings and grounds, are two 8-k.w., 125-volt, direct-current generators, each directly connected to a vertical single cylinder steam engine.

All live steam piping was installed with long radius pipe bends, and properly covered. The exhaust lines were so installed that any piece of machinery in either group could operate with any other piece of machinery in the other group exhausting into either condenser. The condensate and trap discharges were returned to the heater through a common return line.

For each plant there was installed a machine shop, consisting of lathe, drill press, emery grinder, forge and anvil and the necessary bench tools, including pipe threading and cutting machines. There was also furnished for each plant a 22-in. gage industrial railway, with turntable, and a 40-cu.ft. coal charging car.

The Plant Buildings

Special attention was given to the exterior and interior finish of the buildings. All buildings were plastered and present the appearance of smoothly finished concrete buildings. The exteriors were plastered with a cement mortar containing a special coloring matter, so that they appear to be built with a buff-colored concrete. The interiors were painted the most desirable colors and the walls and ceilings of the filter house are hand frescoed.

Curb and gutter and paved driveways connect all buildings with the main driveway from the city. The buildings are all connected with an ornamental concrete tile sidewalk. In front of each power house there is an ornamental fountain and ornamental cast iron lighting standards to light the grounds. Special care was taken in grading up the grounds and around the settling basins. The appearance of the plants as a whole is in keeping with the artistic requirements of the Latin-Americans, for which they are justly famed.

Organization and Personnel

The Ulen Contracting Company, in March, 1916, after securing the contract, sold to the American International Corporation $4,000,000 of the Uruguayan bonds issued in payment for the work. At the same time Stone & Webster, engineers, became financially interested in the work and were represented in Uruguay by Mr. T. A. Devaney, chief accountant, and Mr. A. A. Northrop, progress engineer. The entire work was engineered and constructed by the Ulen Contracting Company, and about fifty of their men from their North American organization were sent to Uruguay. Mr. T. S. Shepperd, vice president of the company and general manager of the Montevideo office, was in immediate charge of the work. The company maintains offices at 120 Broadway, New York; 38 South Dearborn street, Chicago, and 1467 Ituzaingo, Montevideo.

JUST BY WAY OF LOCAL COLOR.
The Riverside Laundry, Illustrating Why Steam Laundries Do Not Pay in Uruguay—A Peon Would Not Feel Dressed Up Without His Knife.

PAVEMENT DESIGN AND CONSTRUCTION

Policy and Procedure of U. S. Highways Council During the War

Effective September 10, 1918

The United States Highways Council, J. E. Pennybacker, secretary, Willard Building, Washington, D. C., makes the following announcement with reference to policy and procedure as to highway and street work during the period of the war:

Approval Required

1. All proposed highway, street, culvert and bridge construction, reconstruction and maintenance involving (a) the issuance of bonds, (b) the use of rail or water transportation, (c) the use of coal or oil as fuel, or (d) the use of cement, brick, asphalt, oil, tar, crushed stone or steel (also sand and gravel where shortage exists), as highway material, should first be submitted for approval to the United States Highways Council through the appropriate state highway department. Forms have been prepared for this purpose and a supply placed with each state highway department. No manufacturer will furnish any road-building material until the project has been approved by the United States Highways Council.

Approval Confined to Essential Roads and Streets

2. The council again urges that new highway and street construction be confined to the most essential needs. If this is done there will be a far greater probability that the work thus selected can be promptly and effectively carried through to completion than if an amount far in excess of the available facilities were to be undertaken.

The council, in passing upon the projects which come before it, will give first consideration to maintenance with a view to conserving all the highways already completed, if possible.

Reconstruction will be favorably considered by the council only where it is clearly established that maintenance is no longer possible except at prohibitive cost.

Relative Merit of New Construction Projects

New construction will be given consideration by the council in the following relative order of importance:

(1) Highways and streets of military value;
(2) Highways and streets of national economic value;
(3) Unfinished contracts involving contractural obligations (incurred prior to April 5, 1918, where bond issue is in-

volved) which may not be disturbed without serious consequences;

(4) Streets and highways which, although not of national economic importance, are of such extreme local importance if the construction of which has progressed to such a point as to cause serious hardship if their construction or completion is postponed.

Council Hopes to Aid Approved Projects

The council is hopeful that the selective consideration of new highway and street construction by the township, county and municipal officials and in turn by the state highway departments will so materially eliminate the less essential projects as to make it possible for the council to render active aid on the projects it approved. The aid contemplated will be in the form of such action by the other government agencies involved as will remove obstacles to the speedy completion of the projects.

Definition of Highways of Military and National Economic Value

3. By way of definition of highways of military and national economic value the council offers the following:

(a) A highway of military value is one used regularly for the transportation of military supplies in considerable quantity; for the movement, as an established practice, of army truck trains, or which is essential to the efficient operation of a military cantonment, post or plant.

(b) A highway of national economic value is one which serves or will serve, if properly improved, directly to promote the welfare of the nation and not merely the local welfare. As examples it may be stated that in this class would be placed (1) highways which, although not directly used for military purposes, yet serve to help win the war by greatly facilitating the output or movement of war munitions and supplies; (2) highways which can clearly be shown to relieve congestion on railroad lines in a territory which is actually in need of such relief; (3) highways which give access to or promote the output of natural products needed by the nation to a marked degree; (4) highways which further housing operations undertaken by the federal government or by other agencies, with the approval of the federal government, would justify at times this designation.

State Highway Departments Requested to Disapprove Freely

4. State highway departments are requested to give most careful consideration to each application on its merits in the light of the policy announced by the council, and to exercise the power of disapproval freely. Only the projects approved by the state highway department will be considered by the council unless the department itself is in doubt and wishes a decision in the nature of a precedent.

Council Will Soon Begin to Formulate 1919 Program

5. The council will shortly begin, in co-operation with the Office of Public Roads of the Department of Agriculture, and the state highway departments of the several states, the preparation of a program of road and street construction, reconstruction and maintenance throughout the United States for the working season of 1919. The purpose of the program is to obtain an approximation of the character and amount of street and highway work deemed essential in 1919, together with an approximation of the amount and character of financing required, the amount and character of the various materials entering into the work, the extent to which rail and water transportation will be involved, and the probable demands upon the labor supply. The preparation of the program in each state will be directed by the state highway department, and will cover all state, county, township and municipal highway and street work.

Forms Are Provided

6. For the information of the state highway departments as to procedure forms are provided.

Form H. C.-3: Application to United States Highways Council for approval of project. This form should be filled out and signed by the public officials who are seeking approval of the project, and should then be filed with the state highway department. If the state highway department approves the application, it enters appropriate recommendation and certification on the last sheet of the form and transmits the application in duplicate to the United States Highways Council. The application is then given a serial number and its receipt acknowledged. It is then considered by the council and appropriate references made to the respective government agencies interested. The applicant and the state highway department are duly advised as to action taken. Forms F. 1 and F. 2 comprise application for approval of delivery of bituminous materials and certification of the application by the state highway department. These forms have been superseded by Form H. C.-3, but may be used if so desired where only bituminous materials are required.

Form H. C.-4: Schedule for use in submiting program of proposed highway and street work during the working season of 1919. This schedule is to be made up in four groups, namely, (1) state, (2) counties, (3) towns, townships or districts, and (4) municipalities. For each of these groups three schedules, respectively, construction, reconstruction and maintenance, are to be submitted. Definitions of construction, reconstruction and maintenance, respectively, are given on Form H. C.-4.

Announcement of June 20, 1918: A brief summary giving organization and purposes of the United States Highways Council, and showing the relation of various organizations represented on the council to highway work.

Circular No. C. S. 13, United States Railroad Administration: Rules promulgated to govern car supply for stone, sand and gravel, showing conditions under which open-top cars may be supplied by railroads and providing for application to the director of the Bureau of Public Roads, United States Department of Agriculture, where local car supply is insufficient. The representatives of the organizations mentioned in paragraph 5 of this circular comprise the United States Highways Council.

Applications Should Be Signed by Officials in Charge Rather than by Contractors

The council emphasizes the desirability of having the applications, which are made to the council for approval, signed by the officials in charge of the work rather than by contractors, as it is earnestly desired by the council that the state, county, township and municipal officials responsible for highway and street work shall actively assume responsibility in dealing with the difficult highway problems incident to the war situation.

The council will readily give its attention to any suggestions as to points which should further be brought out in making the policy and procedure of the council more clearly understood by the public.

Present Need of Correct Interpretation of Pavement Behavior Under Constantly Increasing Traffic Requirements

By Maurice B. Grecnough, Assistant Secretary, National Paving Brick Manufacturers' Association, Cleveland, Ohio

The public is entitled to receive thoughtful and correct interpretation of pavement behavior from its engineers and officials. Growing use of highways for industrial, commercial and agricultural transport has imposed burdens upon some pavements that were beyond their capacity to bear. Imperfections have been made apparent that, to the eye of the layman, provoke hasty and not infrequently wholly incorrect conclusions. In the main, these conclusions have two effects, both disastrous: the public may lose faith in its engineers,

and in the minds of people generally may be fostered a check to highway transportation that the country can ill-afford to suffer.

Two Groups of Improved Roads

In the first place, the public needs to have impressed upon its mind that there are distinctions to the term "improved roads"; that surfaces employed lie in two groups, the one embracing macadam and its modifications or amplifications, and the various bituminous concretes; the other, the strictly hard surfaced pavements of which brick is one. Road improvements of the first group depend for their continued integrity after construction upon ceaseless and unremitting maintenance and repair, if at any time, previous energy and money expended are not to be irrecoverably lost. It is this class that comprises 98% of the country's improved road mileage. . The remaining 2%, only, is paved with inherently wear-resisting materials, which, like brick, require little or no maintenance and repair *provided type was correctly chosen and the details of construction correctly carried out.*

Many Roads Foredoomed to Failure

Precedent and lack of discriminating judgment have been responsible for locating many miles of Group 1 pavements where, even in pre-war times, traffic could be certainly expected in excess of capacity. Uneconomical and wasteful in those days, the evidence of the past year or two have simply reinforced the degree of waste. The public needs to be reminded that all road improvement is not wasteful merely because a meritorious type of improvement was misplaced; that there are types of improvement that could have served the same traffic without a blemish. Unreasoning pursuance of the doctrine of initial cheapness, while having an insinuating appeal to the superficial mind, has reacted many times against its devotees.

Duty and Opportunity of Highway Engineers

When pavements that should bear any degree of traffic without developing flaws do show imperfection, the layman frequently jumps to the conclusion that there is no hope whatever in road improvement, or that the particular pavement was not the correct type of its kind. In this connection, a concrete base is often held to be the solution—a sort of panacea of all ills to which pavements are heir. Others declare with equal vehemence that drainage of the subgrade provided artificially would have been the preventive. And yet we know that pavements have shown faults that were built upon concrete bases or that were artificially drained. It is the duty and opportunity of engineers to foster the truth about these things in the public mind.

Types of Brick Pavements

Let brick pavements serve to illustrate the point. There are many types or ways which the individually durable unit may be incorporated into a pavement. The brick itself is inherently wear resisting. Skill in designing brick pavements is exemplified by discrimination and economy in choosing the correct type. Thus brick pavements may be built upon natural soil, gravel, rolled stone or slag, worn-out macadam, or concrete bases. No one of these bases is of universal usefulness.

VIEWS OF TYPICAL, MODERN BRICK HIGHWAYS.
Left: View of the Geneva and Ashtabula, Ohio, Road. A Broad, Durable Track. Right: View on the Brook Park, Ohio, Road Between State and Berea Roads.

The brick may be bedded in sand, a cement-sand mixture or directly in a green concrete base. Sand, bituminous or cement grout filler may be used in the joints. Brick may be laid on edge or flatwise.

Out of all these possibilities it is permitted to build pavements, affording the wear resistance of brick, to meet economically any degree of traffic and any reasonable amount of funds available. These are advantages that may be lost to the public in the hands of unthoughtful designers.

Details of Construction Are All-Important

Once a type is chosen, its details of construction ought to be executed with the best knowledge and intent known for that type. To revert to drainage: if subsoil drainage is required, it should be supplied; if the base is rolled stone, it should be prepared to the best of the builder's ability; if the base is concrete, the concrete should be thoroughly mixed, carefully laid and finished; and so on, each detail from subsoil to surface must be right. Given correct choice of type for the traffic, thorough workmanship and diligent supervision, traffic may use the pavement without further concern for its welfare. The same arguments apply equally well to pavements of any character, modified only by the inherent stabilities of the two general groups of surfaces mentioned.

Effect of Governmental Restrictions

Effects of governmental restriction on road improvement and maintenance are of course, now making themselves felt in making previous expenditures completely irrecoverable, so that, owing to the preponderating 98% of maintenance—requiring streets and roads, our highway improvements are wearing out faster than they are being replaced. This was even true in normal times; they are going faster since governmental restriction was imposed.

Virtues of Group 1 pavements to serve as foundations for Group 2 surfaces are being lost, and all the while are present the growing requirements of the country for highway transport—a growth that is in its infancy. Roads are imperatively needed for the farmers, merchants and manufacturers of the nation. Economic and military necessities know no qualification. Without adequate roads, the country is suffering loss of strength. Engineers and officials are in a position to point the way to the public generally and to other less well informed officials how to augment the nation's war strength. Improved roads are our greatest factor in consolidating economic resources, and the people of the country deserve to have highway problems and use of highway improvements placed before them in their true significance.

VIEWS ILLUSTRATING COMMERCIAL AND MILITARY ADVANTAGES OF PERMANENT TYPE OF HIGHWAY CONSTRUCTION.

Left: The Geneva and Ashtabula, Ohio, Brick Road. Food Raised Along This Road Is Doubly Valuable Through Potential Mobility. Right: The Center Ridge Brick Road in Cuyahoga County, Ohio. The Traffic Shown is Military but Food or Freight Can be Hauled Over the Road Equally Well Throughout the Year.

Work of the Highway Industries Association and Necessity for Closer Co-operation Between Federal, State and County Road Authorities

Address of H. G. Shirley, Secretary Highway Industries Association, at Annual Convention of North Carolina Good Roads Association

The Highway Industries Association was formed about the first of the year, it being realized by all manufacturers of road materials, machinery, etc., that it was very necessary to get together and form an association whose duties it would be to promote the interest of good roads and nothing else.

Officers

The association was organized in Chicago on January 21, and the following officers were elected:

President, S. M. Williams, Lima, Ohio; vice president, A. R. Hirst, Madison, Wis.; second vice president, E. J. Mehren, New York City; third vice president, S. T. Henry, Washington, D. C.; secretary, H. G. Shirley, 302 Maryland Bldg., Washington, D. C.

Aims and Objects

The aims and objects of the association are as follows:

To assist in co-ordinating the highways with the other transportation agencies of the country; to encourage the development of highways that will advance the economic life of the nation; stimulate their use in such a manner as to facilitate and cheapen the transportation of food, raw materials and finished products, and to co-operate with government agencies, both State and National, to the end that our highways may be of maximum service in the transportation system of the country.

Activities of the Association

The association has nothing to buy or to sell except the idea of good roads and the benefits derived therefrom. We have taken an active part in the road development question since our organization, first, by having highway transportation and improvement discussed at the annual meeting of the United States Chamber of Commerce at Chicago, and the preparation of certain resolutions calling for a federal highway policy and the centralization of authority.

We have assisted the state highway departments, the contractors and material people in trying to have the most radical advance in freight rates reduced to a conservative figure, and to have the contractors relieved from the operation of this order on those contracts let previous to the promulgation of the order.

We will assist any road organization or highway department in supplying literature and speakers in any campaign for better roads or for larger appropriations and in every way possible for the advancement of the good roads subject.

It is realized by all industries who manufacture material for the construction of roads and for the use thereof that it is to their interest, as well as to the general welfare of the country, that road construction should be put on a firm basis and that some effort should be made at least to keep pace with the demands and needs of the country in road building.

Why It Is Necessary to Speed Up Road Improvements

From the preliminary studies made it is shown that the rate of surfacing of roads, as heretofore carried on, has not kept up with the development of the country, there being actually opened up each year approximately 50,000 miles of road, while the total number that has been surfaced has not exceeded 15,000 miles per year. It is clearly shown that the

country is opening roads at least three times faster than surfacing is proceeding. When you consider that there already exist approximately 2,750,000 miles of roads, of which not over 300,000 miles have been improved, it will be clearly demonstrated that to improve the remaining 2,500,000 miles would require, at the rate we have been going, something like 166 2/3 years. Granting that the total mileage should not be improved and is not of sufficient recreational or commercial value to justify an expenditure for improved surface, it cannot be denied that at least 20 per cent of this total mileage should be undertaken as soon as possible.

It would require, at the rate that we have heretofore gone, 33 years to complete the 20 per cent, and by the end of the 33 years there would have been opened up 1,650,000 miles of new roads, giving a gross total of unimproved roads at the end of that period of 3,650,000 miles. This is based on the assumption that the number of miles opened annually will be the same throughout this period.

This we know is not true, for as the country becomes more closely settled, a greater number of miles of roads each year will be opened up, and I should say that at the end of 33 years there would be something like 4,000,000 miles to be improved.

To provide for the proper surfacing of the opened roads it will therefore be necessary for the states, counties and townships at least to double their appropriations for road improvement and for the national government to participate largely in the development and construction of a federal system of highways.

Federal, State, County and Township Road Systems

The time has arrived when there should be a federal system of roads, a state system of roads and county and township systems, and it is the object of the Highway Industries Association to co-operate with all these bodies to the end that this most beneficial result will be obtained.

It is necessary, however, that before we can expect any great improvement, closer relations and more earnest co-operation should be given by the federal government, state highway departments, the counties and townships to each other, and one of the most important agencies to which we shall have to look for the greatest amount of this work to be accomplished will be the state highway departments, and, therefore, I wish more particularly to call attention to the important functions of such a department and the great necessity for a hearty co-operation with them.

Importance of State Highway Departments

The highway departments of many states have become the most important single branch of the state government, and in many instances supervise an annual expenditure of more than the total amount expended by all the other departments of the state.

New Jersey, in the early nineties, established a state highway department, and was soon followed by Massachusetts and other states, until today we have a state highway department in every state. The authority of these 48 highway departments varies from an educational and advisory capacity to having full charge of all expenditures, plans, and the supervision of the work.

The time is here when it is necessary for the federal government to take over, build and maintain the trunk lines of this nation, both east and west and north and south; the state highway departments to take over, build and maintain the main state arteries leading into the federal system, and the counties and townships to take over those roads of local importance.

The relationship between these departments, or subdivisions, of our government is so close that one cannot do effective work without the active help and co-operation of the other.

The great importance of the state highway departments has been increasing with leaps and bounds, until today we see the state highway department the actual head of all road and street work in their respective states, for no city, town, county or township can proceed with any road work where the materials have to be transported by rail, until they have first secured the approval of their state highway department, for the United States Highways Council will not consider any requests for shipment of materials or other road supplies until first passed on and approved by the state highway departments.

The war has only emphasized the close and logical co-operation that is necessary between the state and federal government to secure the very best results, and the same co-operation must exist between the counties and townships and the highway departments to secure similar results.

Support the State Highway Departments

The state highway departments are institutions of the state government that have come to stay, and will grow into greater usefulness and importance as time goes on. Their usefulness may be delayed by petty jealousies, small politicians and sectional narrowness, but they are such important constructive units that they are bound to take a most active part in state and national road affairs.

Through political manipulations and sectional narrowness, I have known state highway departments to be legislated out of existence, or their appropriations and powers so restricted that they were practically useless, and while struggling under such handicaps and burdens, they were being attacked and criticised in the most vitriolic and scathing language; but from the embers of the destroyed structure, restricted laws or burdens, emerged a more permanent and more powerful state highway department.

It is a trite saying that "Man can retard progress but he can not stop it," and thank God he can not.

There are many who seem to think that it is their special mission in life to object to everything that goes to the promotion and advancement of the general welfare of the state, or changes the condition that existed 20 years ago. This species, unfortunately, is found in large numbers in every state, and especially in road matters. It is therefore the duty of every one who realizes the importance of roads to do everything they can to overcome this feeling. Nine men out of ten will agree with you that the more important roads of a state and neighborhood should be improved, but when you suggest to him that the proper way to secure this desired result would be by giving his state highway department greater authority and larger appropriations so that it could accomplish things, he will immediately tell you that the state can not afford to increase its taxes and that the roads will cost too much, when, in fact, the highest tax he is paying is that levied by the mud road on transportation and he, as well as every other citizen of the state, can not afford not to spend more money to get rid of this most expensive burden.

Co-operation Is Essential

It is, therefore, most essential that the counties and towns should co-operate with their state highway departments to the fullest extent, for without the proper co-operation and support, both morally and financially, the best results can not be secured.

The national government undoubtedly will undertake to assist in constructing the main trunk lines of the country, and we may rest assured that they will not deal with a smaller unit than a state, and for this reason it is most essential that each state clothe its highway department with proper powers and appropriations to meet all the requirements that may be placed on such road construction by the national government. If any state is so short-sighted as not to place its state highway department in a strong position, then she can not expect to receive the same benefits from the national government as her more fortunate sisters who have highway departments well equipped to undertake almost any work that the United States government may require, or to formulate plans of state systems to tie in with the national system, so

as to give the state the most advantage for the least expenditure.

I can not emphasize too forcefully the great necessity of formulating a plan and system of state and county highways, for the development and returns from such development that will take place in the state when such a system has been constructed will far exceed the cost of such a system, not considering the recreational and many other advantages that are derived therefrom.

The Highway Industries Association is purely a co-operative body, and therefore wishes to advise all road workers if it can be of any assistance it will be only too glad to be called upon. Our organization is for the promotion of the good roads idea; we have nothing to hide and everything is open and above-board. We realize that it is to the advantage of the highway industries to have roads improved, as well as to the general advancement and welfare of the country, and we feel that all our labor will have a two-fold benefit.

Distribution of Costs on Street Paving Construction

By Ray S. Blinn, Civil Engineer, Lock Box 308, Port Clinton, Ohio

There are a few simple rules that govern account classifications on street pavement construction.

First, where several jobs of like character are being handled at the same time, it is more important to determine the cost of the operation than the cost of the job.

For instance, should the contractor be constructing, say, five brick paving jobs at the same time under similar specifications, and where men are constantly being shifted to one street from another, or working on junctures, it is best to distribute the expenditures not by jobs, but under such headings as grading, curbing, draining, foundation, cushion, laying and filling. In other words, it is the cost of the operation which concerns the contractor rather than the cost of the job.

Second, all operations such as enumerated above can be primarily classified as labor, material and overhead.

Now, if as close a distribution as this is decided upon, it is well to make a list before opening the books as to just what items will come under each head. We have always classified man power, horse power and machinery power as labor. It is a fine question as to the propriety of charging coal, gasoline and depreciation of labor-saving machinery to the labor side of the column, but it seems to me that is proper.

Material embraces the cost of material at factory, the freight or any supplies that go to make a part of the job for which pay is received, and nothing else.

Overhead embraces such miscellaneous items as salaries, office expenses, trips, telegrams and so on, that become necessary for the carrying on of the general business.

Third, the time to classify is at the time the bank check is made. The proper form of check is the voucher check. Upon the front or back of the voucher stub should be the classification printed that is desired, and all books posted from these stubs. Even all such small cash expenditures as car fares, all emergency cash outlays, should be entered on a memorandum book and check issued to the disburser at the end of the week, or at least before the object of expenditure is forgotten and it is erroneously classified.

The above rules comprise my idea of cost distribution methods for small contractors on similar work, such as paving construction. At the present time, while paving work is at a low mark, is a good time to study cost accounting.

As outlined in a previous article, make the classification simple and large. It does not pay to impose any unnecessary tasks upon foreman or field men. It is hard to get them away from the usual name and time book. If you can, or rather where you can, try the individual card system. When they see how easy it is to let the card go with the man, and the elimination of argument with the men over shortages, the usual foreman will readily acquiesce.

For larger business there are cross-classifications between "Character of the Transaction" and "Object of Expenditures." Under the first are detailed personal service, contractual service, supplies, materials and gratuities. Under the second are operation, maintenance of equipment, refunds, etc. For extended systems beyond this look up the bibliography of the New York Bureau of Municipal Research, or the various departments at Washington. These have most exhaustive studies for the benefit of those who want to make a hobby of it.

Some Design and Construction Features of Concrete Roads

By A. N. Johnson, Consulting Highway Engineer, Portland Cement Association, 111 W. Washington St., Chicago

In the design of a road, there are two essential dimensions—width and thickness—which must be determined and which it is evident are the chief factors controlling the cost per unit of length. As it is always the endeavor to make this cost as little as possible, too many roads are made both too narrow and too thin.

Width of Pavement

As the thickness of the pavement is to a certain extent a function of the width, the width is the dimension to be first determined. Owing to the greatly increased weight of traffic and to the fact that a large proportion of the traffic on the main roads is self-propelled, it becomes necessary that the width of the paved portion of the road should be sufficient to make it unnecessary for any of the wheels of a vehicle to leave the pavement and run upon the soft side or shoulder. If the traffic is all in one direction, and not so numerous but that a single track will be sufficient to care for it, then the paved portion of the road need be no wider than is required for a single vehicle. This is a condition, however, that is never experienced practically, although it is approached on a number of roads. It frequently happens that at a given time of day nearly all the traffic is in a given direction, particularly the loaded vehicles, so that it is rare for two loaded vehicles to meet. If one vehicle must leave the paved portion of the road it will be the unloaded vehicle. These conditions, combined with the fact that there is so limited a mileage of improved roads in most sections of the country, together with the endeavor to build a road between certain points with half as much money as should be expended, has made it expedient, apparently, to construct many miles of single track roads.

Traffic Increase Follows Road Improvement

Experience has shown, however, that no sooner has a road been improved than the amount of traffic it carries is increased many fold. Scarcely a year passes before the community discovers that the road is too narow. If it were possible to handle such matters in the most efficient way, it is doubtful if there would be found public roads on which a single track construction could be justified. Where a single track road is constructed it is an utter waste of money to make it wider than is necessary for single track traffic, if such a width is not sufficient for two lines of vehicles. Ample experience has demonstrated that 9 or 10 ft. gives a width sufficient for a single line of motor vehicles to be operated with safety and comfort. Therefore, to construct a 12, 13 or 14 ft. width is merely to waste the extra 3, 4 or 5 ft. of pavement, as the case may be. As it is certain that it will be but a short time before the community discovers that the single track is insufficient, roads should be so built as to make it possible to widen to a two-track road at a minimum expense in the future. It should, therefore, be laid with one edge at the center of the right of way of the highway.

The majority of roads are now being paved for at least

two-track traffic. It should require no argument to convince anyone who has had any experience on roads of less width under our modern traffic conditions that 18 ft. is a minimum to allow for two-track traffic. Anyone possessed of the slightest vision should realize that on our main roads a less width is barely short of criminal. The next practical width should be one that would accommodate three lines of traffic. Such a width of road is called for where at a given time of day there is considerable traffic movement in one direction which is reversed at a later period of the day. A three-track road under such circumstances may be as serviceable as a four-track road. For each line of traffic to be accommodated, 9 ft. is a minimum width to allow. A better width, one that will prove to give greater safety and comfort, would be 10 ft. And the time is not far distant when we shall see hundreds of miles of roads constructed 30 and 40 ft. in width to accommodate intertown highway traffic.

Thickness of Pavement

The proper thickness for a pavement of any good type must at best be founded on empirical rules. It is a fact, as with many other features of highway design, we have no data on which to base sound conclusions as to the proper thickness. The increase in the weight of loads which are hauled, and will be hauled over our highways, makes it all the more necessary that an investigation should be made which will determine this very important factor.

The general practice in concrete road construction has been to place roads of 18 to 30 ft. in width with a thickness of 6 in., at the sides and from 8 to 9 in. at the center. There are many concrete roads built with a thickness of 5 in. at the sides and from 7 to 8 in. at the center.

Without more precise data it is idle to offer much theoretical discussion as to the proper thickness of a pavement. Practical judgment would indicate that in the face of the increasing weight of traffic, it would be folly to decrease the thickness. This has been demonstrated practically in the instance of certain roads built 4 to 4½ in. in thickness, which in a number of instances were broken by track traffic. If we may allow ourselves to theorize for a moment, let us suppose the 4-in. thickness was just at the breaking strength of the slab. Then if we are to use the usual factor of safety of 4 our slab should be 8 in. thick. Without more exact data at hand this illustration affords at least some basis for a recommendation that a concrete road slab should not be less than 8 in. thick at the sides if it is to support heavy truck traffic.

Tables I and II will be of help in making estimates for concrete roads of various widths and thicknesses. It is to be noted that the 9 and 10 ft. widths are given as half the quantities for 18 and 20 ft. width roads on the assumption that the narrower widths are laid at one side and are subsequently to be widened to full width.

Side Forms

More attention is now given to the placing of side forms than was formerly realized to be necessary. Experience has shown that a number of concrete roads otherwise well constructed have long undulations in the surface clearly attributable to the fact that the side forms had not been held true to grade, particularly where one section of the forms joined its neighbor. It is essential that the side forms shall be firmly supported so that if a heavy tamping template or a machine tamper is used it will not tend to sag the forms at the joints. An excellent way to insure proper support for side forms is first to drive stakes to a firm bearing, with their tops at such an elevation that when the side forms rest upon them their upper edge will be true to the grade of the road.

Where any considerable mileage is under way it is economical for a contractor to equip himself with metal forms. These are usually a channel shape with special devices for holding them firmly in place and at the same time make it possible to remove easily the pins or stakes which support them.

The modern finishing machines use the side forms as a track and furnish an added reason that they be placed firmly and accurately.

Equipment for Handling Materials

It was common practice on the earlier concrete roads to haul the materials to the work by teams. The subgrade being prepared, materials were dumped upon it ready for use in the mixer into which they were shoveled by hand. On most of the work it was customery to handle the materials by means of wheelbarrows which were used as measuring boxes. It is thus clear that the hauling and handling of materials to the mixer constituted a large portion of the expense of laying a concrete road, being from 30 to 35 per cent. of the total cost.

An opportunity was presented for a very considerable saving in handling these materials and special attention was given to this phase of the work as larger contracts were awarded and a much longer mileage constructed at one time. After a trial of a number of methods, including motor trucks and tractors with trailers, the most satisfactory and most economical method has been the industrial railroad which runs upon a narrow gauge, light track which is laid from the point the materials are received extending thence alongside the road to be constructed. It still remained the practice to dump the materials on the

TABLE I—AREAS OF CROSS SECTION, CUBIC YARDS PER LINEAR FOOT, AND SQUARE YARDS OF SURFACE FOR CONCRETE ROADS FOR VARIOUS WIDTHS AND THICKNESSES.

Width Ft.	Sides In.	Thickness Center In.	Average In.	Area of Cross section Sq. ft.	Cubic Yards per linear foot of pavement	Sq. yds. per mile
9	6	8	7.33	5.50	.204	5280
10	6	8	7.33	6.111	.227	5867
18	6	8	7.333	11.000	.407	10560
18	7	9	8.333	12.500	.463	10560
18	8	10	9.333	14.000	.519	10560
20	6	8	7.333	12.222	.453	11733
20	7	9	8.333	13.777	.510	11733
20	8	10	9.333	15.555	.576	11733
24	6	8	7.333	14.667	.543	14080
24	7	9	8.333	16.667	.617	14080
24	8	10	9.333	18.667	.691	14080
26	6	8½	7.667	16.611	.615	15253
26	7	9½	8.667	18.777	.695	15253
26	8	10½	9.667	20.944	.776	15253
27	6	9	8.000	18.000	.667	15840
27	8	11	10.000	22.500	.833	15840
30	6	9	8.000	20.000	.741	17600
30	8	11	10.000	25.000	.926	17600
36	6	9½	8.333	25.000	.926	21120
36	8	11½	10.333	31.000	1.148	21120
40	6	10	8.667	28.888	1.070	23467
40	8	12	10.667	35.556	1.317	23467

TABLE II—QUANTITIES OF MATERIALS REQUIRED PER LINEAR FOOT OF CONCRETE ROADS FOR WIDTHS AND THICKNESSES SHOWN.

Quantities based on 1 barrel cement, equal to 4 cu. ft. and that voids in stone average 45 per cent. Adapted from quantities as given by Taylor & Thompson for 1 cu. yd. concrete.

Cement		Sand		Stone	
1:2:3	1.74 bbls.	1:2:3	0.52 cu. yds.	1:2:3	0.77 cu. yds.
1:1½:3	1.91 bbls.	1:1½:3	0.42 cu. yds.	1:1½:3	0.85 cu. yds.

Width Ft.	Thickness Inches Sides	Center	Cement Barrels 1:2:3	Cement Barrels 1:1½:3	Sand Cubic Yards 1:2:3	Sand Cubic Yards 1:1½:3	Rock or Pebbles Cubic Yards 1:2:3	Rock or Pebbles Cubic Yards 1:1½:3
9	6	8	.355	.389	.106	.086	.157	.173
10	6	8	.394	.433	.118	.095	.175	.193
18	6	8	.708	.777	.212	.171	.313	.346
18	7	9	.806	.884	.241	.194	.357	.394
18	8	10	.903	.991	.270	.218	.400	.441
20	6	8	.788	.865	.236	.190	.349	.385
20	7	9	.887	.974	.265	.214	.393	.434
20	8	10	1.002	1.100	.300	.242	.444	.490
24	6	8	.945	1.037	.282	.228	.418	.462
24	7	9	1.074	1.178	.321	.259	.475	.524
24	8	10	1.202	1.320	.359	.290	.532	.587
26	6	8½	1.070	1.175	.320	.258	.474	.523
26	7	9½	1.209	1.327	.361	.292	.535	.591
26	8	10½	1.350	1.482	.404	.326	.598	.660
27	6	9	1.161	1.274	.347	.280	.514	.567
27	8	11	1.449	1.591	.433	.350	.641	.708
30	6	9	1.289	1.415	.385	.311	.571	.630
30	8	11	1.611	1.769	.482	.389	.713	.787
36	6	9½	1.611	1.769	.482	.389	.713	.787
36	8	11½	1.998	2.193	.597	.482	.884	.976
40	6	10	1.862	2.044	.556	.449	.824	.910
40	8	12	2.292	2.515	.685	.553	1.014	1.119

roadbed and rehandle them into the mixer, but methods of handling materials so that it is unnecessary to store them upon the subgrade have now been developed. The small cars are so constructed that they may be readily removed by a light derrick attached to the mixer and the entire contents of a single car dumped directly into the hopper of the mixer. Each car carries the correct proportions of cement, sand and coarse aggregate.

By the proper track arrangement it is possible so to arrange a distribution of the cars and locomotive that the mixer always has a supply of material and the locomotive is not held for any length of time. This method is not only the most economical yet developed, but has a distinct advantage in that it is not necessary to put the materials upon the subgrade, which avoids getting some of the earth of the subgrade into the concrete, or the other alternative of wasting an appreciable amount of the aggregates. By this arrangement it is possible to haul materials for 10 to 12 miles at a cost that is no greater than for a two or three mile haul with teams.

The length of roads now placed under a single contract are large enough to warrant a contractor investing a very considerable amount for a complete outfit and giving very close study to his equipment layout. Engineers in planning work must be familiar with the most economical methods of handling materials and know at what rail points it will be most economical to receive the materials and the roads that will be necessary to have occupied temporarily with tracks. It is becoming more and more, and should be, a function of the engineer in charge of work not only to design it properly but to lay out the order of construction and know that it will be carried on not only in the most economical way, but with the least inconvenience to the public.

Placing Concrete

The necessity for care in placing concrete from the mixer onto the subgrade has come to be more fully appreciated as more experience has been gained. If it happens for any cause that a batch of concrete as deposited in the road tends to have portions of the aggregate segregated it is of importance that the concrete shall be re-distributed so that there shall be no segregation, particularly towards the surface. The drier the mixture the less tendency there is for this segregation, which furnishes an additional reason for care in the amount of water used in the mixer.

On some of the earlier roads the concrete was distributed by shovels and not sufficient care taken to insure a true surface. The use of a template to strike the concrete on the narrower roads remedied this to a great extent. On wider roads, those much over 24 ft. in width, it becomes very difficult for workmen to manipulate a template extending across the pavement; either the template, in order to be sufficiently stiff, is too heavy to handle, or if light enough to handle is not sufficiently stiff to hold its shape and therefore its purpose defeated. It is the best practice to have two templates, the first one being considerably heavier than the second one.

Much of the unevenness resulting from inattention or inability to secure a true surface is remedied by the use of a roller. The roller, which is operated transversely to the direction of travel upon the road, has the tendency to smooth out waves in the surface of the concrete which have their axes in a transverse direction, and if waves remain after the use of the roller their axes are longitudinal and, therefore, cause no discomfort or inconvenience to traffic.

Reinforcement of Concrete Roads

The precise function or, perhaps more accurately, the manner in which reinforcement affects the service rendered by concrete roads is by no means clear. Certainly there has been advanced no satisfactory basis on which to make recommendations as to the proper method of reinforcing a concrete road.

As a result of careful observation of something over 30 million sq. yds of concrete roads, some of which were reinforced and some were not, the conclusion is reached that the reinforcement that has been used, generally averaging about 28 lbs. of metal per 100 sq. ft. of pavement, has not lessened the number of cracks, but has had a marked influence on the width of the cracks that have formed. That is, in the non-reinforced roads a far larger proportion of the cracks have opened sufficiently to become noticeable and require filling with tar or asphalt for proper maintenance. On the reinforced roads a majority of the cracks have not opened up sufficient to be casually noticeable and have not required any filling.

The cracks which occur are usually transverse or longitudinal. Most transverse cracks are occasioned because of the shrinkage in the concrete due to setting. In this connection it is interesting to note a difference in the number of transverse cracks that occur in concrete roads laid in warm weather and those laid in the fall, the former having a larger number of cracks.

It is evident that these transverse cracks cannot become very much widened by movement of the concrete slab and if given prompt and proper attention do, as a matter of fact, cause very little or no inconvenience whatever.

Longitudinal cracks are occasioned primarily by unequal movement of the foundation. In general, the cause of this movement is due to variation in the moisture content of the subgrade which may occasion either a slight rise or a slight depression. When a longitudinal crack occurs there is opportunity for it to widen as the two portions of the slab tend to separate; so that transverse reinforcement which will tend to hold the two sections of the slab together, although not sufficient to prevent cracking, performs a function of definite value.

As the object to be attained by reinforcement is chiefly to hold portions of the concrete together where a crack has occurred, particularly to hold the edges of the crack together at the surface, the reinforcement should be placed nearer the top surface than the bottom of the slab. If the slab cracks because of tension in the surface then the upper edge of the crack or portion exposed to the surface tends to widen and reinforcement at this point would help hold it together. If a crack occurs because of tension in the lower side of the slab, it will not open up at the surface, therefore no particular harm has resulted, and the reinforcement being in the upper section of the slab will keep it from opening further. It has thus become a general practice to place the reinforcement near the top of the slab, about 2 in. from the surface.

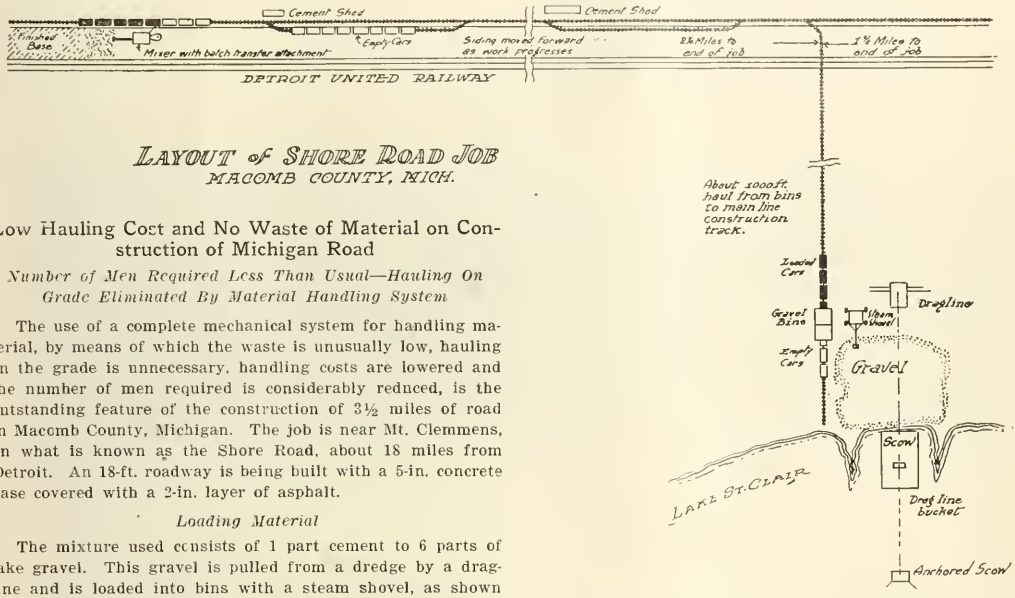
More exact data are necessary before any definite conclusion can be drawn as to the actual economy of reinforcement. Until such are available, it is probable that the use of reinforcement will, to a great extent, depend upon its cost. A good, practical rule to follow in the meantime would be to reinforce those portions of the road where the drainage conditions lead the engineer to expect the greatest disturbance to occur in the subgrade. For example, where the subsoil is sandy or of a gravelly nature, which insures good natural underdrainage conditions, reinforcement would be of the least value, while in cuts through clay hillsides it would be of maximum value. It also should be kept in mind that so far as our present knowledge goes, there is little or no value to be attached to the portion of the reinforcement which is laid longitudinally. Therefore, that type of reinforcement should be used which employs a maximum portion of the metal, transverse of the road.

The tendency has been for an increased use of reinforcement in the construction of concrete roads. Whereas comparatively few concrete pavements were reinforced in the

period from 1909 to 1914, of those that were built in the years 1914 to 1916, inclusive, nearly 32 per cent. were reinforced.

Acknowledgment

The foregoing matter is from the lecture on: "The Development of Concrete Road Construction, by Mr. Johnson, reprinted from the J. E. Aldred Lecture on Engineering Practice, The Johns Hopkins University Press, 1918.



LAYOUT of SHORE ROAD JOB
MACOMB COUNTY, MICH.

Low Hauling Cost and No Waste of Material on Construction of Michigan Road

Number of Men Required Less Than Usual—Hauling On Grade Eliminated By Material Handling System

The use of a complete mechanical system for handling material, by means of which the waste is unusually low, hauling on the grade is unnecessary, handling costs are lowered and the number of men required is considerably reduced, is the outstanding feature of the construction of 3½ miles of road in Macomb County, Michigan. The job is near Mt. Clemmens, on what is known as the Shore Road, about 18 miles from Detroit. An 18-ft. roadway is being built with a 5-in. concrete base covered with a 2-in. layer of asphalt.

Loading Material

The mixture used consists of 1 part cement to 6 parts of lake gravel. This gravel is pulled from a dredge by a dragline and is loaded into bins with a steam shovel, as shown in Fig. 1. These bins were constructed with a clearance between top of car and bottom of bin of 7 ins., so that the material would not flow over the edges of the cars if the gates were left open by careless workmen. Thus the waste of material at the loading point has been prevented as evidenced by the absence of sand piles around the cars in Fig. 2. With this system two men load an 8-car train of 16 batches in 6 to 8 minutes.

Plant Layout

Four loaded cars are pulled by a team of horses from the bins, up a slight grade, to the first siding on the road, as shown in the layout sketch herewith. The team then returns

FIG. 1. SAND BROUGHT BY DRAGLINE TO SHOVEL AND LOADED INTO BINS. FIG. 2. WASTE OF GRAVEL PREVENTED BY SMALL CLEARANCE BETWEEN BOTTOM OF BIN AND TOP OF CAR.

for another string of four cars and the train of eight loaded cars is ready to be hauled to the mixer by a gasoline locomotive which has brought back a string of empties. The track connecting the loading bins with the main line is located just about midway between the east and west ends of the road to be built. This arangement keeps the length of haul at a minimum for all parts of the job.

Concrete Mixing

Each car carries two boxes each holding 20 cu. ft. of lake gravel. The mixer is fitted with the Lakewood batch transfer attachment from which a bail is hung as shown in Fig. 3. This bail is so balanced that it wil stay open, thus permitting a train to move under it without the necessity for swinging the derrick. By means of this apparatus a box of gravel is lifted from the car and dumped into the loading hopper. Three bags of cement are then added and the batch is ready to be mixed. With this arrangement only five men are needed at the loading end of the mixer—three to discharge a box full of gravel into the hopper and two to handle cement. This

FIG. 3. BATCH TRANSFER ATTACHMENT FITTED WITH BAILS TO LIFT BOXES FROM CARS. FIG. 6. FOUR MEN NEEDED AT DISCHARGE END OF MIXER.

is shown in Fig. 4, which also shows the grade free from piles of material due to the methods employed. Also, observing the actions of the men and judging from several pictures taken after a batch was loaded, the men seem to come to rest each time in about the same positions shown in Fig. 5. This would indicate that their work had become almost automatic and, therefore, more efficient. Four men are needed at the discharge end of the mixer as shown in Fig. 6.

Work was started at the west end of the job. Cement was stored in several sheds along the road. It was hauled from the sheds to the mixer in cars, as shown in Fig. 7. Each car holds 60 bags of cement.

Crossing D. U. R. Tracks

As the road parallels the tracks of the Detroit United Railway a method of crossing these tracks with the narrow gauge track was devised as shown in Fig. 8. Plates were bent at right angles, bolted to the bottom of the light rail and to the web of the heavy rail so that the top of the light rail would be held 1¼ in. above the top of the heavy rail. The 20-lb. rail was cut to make a 5-in. gap where the heavy rail had to be crossed. With this arrangement the flange of the 12-in. wheels on the small cars just touches the top of the heavy rail and the chances of derailment are almost eliminated. In fact, no derailment has occurred at this crossing to date.

The work is being completed at the rate of about 400 ft. a day. The best day's work is 512 ft. of finished concrete base.

The layout of the job is indicated by the sketch. As the work progresses the siding nearest the mixer is moved forward about ¼ mile. The moving of these switches is a comparatively easy job as the track is built in 15 ft. sections, and can be quickly taken apart, moved, and assembled.

Advantages of Method of Handling Material

The advantages of this method of handling material are, briefly: A large capacity plant can be used on very narrow roads; there is no loss of material; materials are kept clean because no aggregates come in contact with the ground; proportioning the mix is made simple by the uniform amount of aggregate transported by each car; work is not delayed by bad weather, as muddy subgrades do not interfere with handling the aggregates.

The contractor is Thomas E. Currie, Detroit. The track, switches, cars, mixer and mixer attachments were supplied by The Lakewood Engineering Company, Cleveland, and the plant layout was suggested by that company's engineering department. An Erie shovel is used to handle the sand and a Plymouth gasoline locomotive hauls the cars. The concrete work was started about July 18th, and at the time this article was written a little more than 1½ miles of concrete had been laid.

FIG. 4. ONLY FIVE WORKMEN NEEDED AT CHARGING END OF MIXER. FIG. 5. MEN'S ACTIONS BECOME ALMOST AUTOMATIC.

FIG. 7. CEMENT HAULED IN CARS FROM STORAGE SHEDS TO MIXER. FIG. 8. RIGID CROSSING MAKES DERAILMENT ALMOST IMPOSSIBLE.

Protecting Dangerous Curve on Sheridan Road

As a safety measure to forewarn vehicles of dangerous curves on Sheridan Road through Hubbard's Woods, Winnetka, Ill., the village of Winnetka has installed one of the A. G. A. Railway Light and Signal Company's acetylene-lighted highway danger signals. The installation is illustrated herewith. In this locality there are several steep grades and bad curves where the road winds through the ravines and curves around the small wooded hills.

This signal operates continuously, giving a flashing red light, which may be seen in the daytime as well as night. While during daylight this flashing red light may be distinctly seen at a distance of 200 to 300 ft., it is not so compelling in its indication as after dark, when the effect is very striking,

A. G. A. ACETYLENE-LIGHTED HIGHWAY DANGER SIGNAL AT DANGEROUS CURVE ON SHERIDAN ROAD, NORTH OF CHICAGO.

and the light could undoubtedly be seen for a distance of two or three miles on a straight road and in clear weather.

The words, "Slow—Danger," are visible in the night as well as during the day. At night the white flame, which flashes through the red lens, illuminates also the letters of the sign,

so that the words are distinctly visible for a distance of about 200 ft., which is also about the same distance in which they can be seen by daylight.

It is expected that the village of Winnetka will soon install several more of these signals, making the protection by signals for all dangerous places in Hubbard's Woods complete.

Road Finisher Increases Density of Concrete

A concrete road finishing machine that eliminates the voids in concrete, here illustrated and described, is an important addition to the Lakewood Engineering Company's line of road construction plant. The use of the machine permits an increase in the proportion of coarse aggregate, and the rapid agitation of the aggregate makes possible the use of an unusually dry mixture. In general it may be said that the use of this concrete road finishing machine permits the use of a drier, coarser mixture than could be worked by hand.

The device moves forward under its own power at a speed of about 7 ft. per minute and backs up at a speed of 28 ft. per minute. As the machine travels forward the strike-off spreads the concrete to the necessary height and proper crown. The tamper, located just back of the strike-off, tamps the concrete the first time over with a long, hard stroke. The second time over a short, rapid, up-and-down movement is used, which may be decreased until it is subjecting the concrete to continuous agitation without applying pressure to the mixture. The stroke of the tamper is regulated by the operator and may be varied for different consistencies of concrete as well as for different stages of progress. The float, located at the rear of the machine, produces a smooth finish by sweeping a belt across the surface at a comparatively slow speed.

By subjecting the mixture to the continuous agitation caused by the tamper, the concrete is compacted and the air in it is brought to the surface. The larger stones and only enough mortar to cement them are brought together. Because of the agitating action of the tamper a drier mixture can be used with the Lakewood finisher than would be possible where the work is done by hand. This, of course, results in a stronger concrete and produces a surface free from laitance, silt and light particles which float to the surface of a wet mixture.

The views show the Lakewood concrete road finisher in use on the 15-ft. Belleville (Ill.) Scott Field road, in St. Clair county, where its use has been attracting considerable attention from engineers and contractors. On this work a 1:2:3½ mixture is being used. The Belleville work is being done by Keeley Brothers, of East St. Louis. D. O. Thomas is county highway engineer and Frank Sheetz is engineer in charge of the work. The concrete road will be 6 miles long, 15 ft. wide, 6 ins. thick on the sides and 7½ ins. thick at the center.

The finisher was designed in 1913 by E. G. Carr, while a contractor in California. This type of machine has been used on the construction of about 400 miles of California's famous highways. It is manufactured by the Lakewood Engineering Company, Cleveland, Ohio.

VIEWS OF NEW LAKEWOOD CONCRETE ROAD FINISHER IN USE ON 15 FT. BELLEVILLE (ILL.) SCOTT FIELD ROAD IN ST. CLAIR COUNTY.

WATER WORKS DESIGN AND CONSTRUCTION

Construction Methods Employed in Building the New Intake and Remodeled Reservoirs of the Oshkosh, Wisconsin, Water Works.

By T. B. Jorgensen, Resident Engineer, Oshkosh, Wis.

In connection with the recently constructed water filtration plant, described in the July issue of MUNICIPAL AND COUNTY ENGINEERING, the city of Oshkosh awarded a contract for the construction of a new intake and a connection between the old intake and the new filter plant. The plans and specifications for the intake were prepared by Col. Henry A. Allen, of Chicago. J. Rasmussen & Sons Co., of Oshkosh, were the contractors.

The New Intake and Crib

The new intake consists of about 300 ft. of piping connecting the shore line with the suction well in the filtration plant, and 1,200 ft. of piping from the shore line out in Lake Winnebago. It is constructed of 24-in. cast iron piping, Class B, bell and spigot, with three-ball joints, in the lake section, for expansion.

At the extreme end is constructed a submerged concrete crib, supported on pile foundation, with its high point 9 ft. 8 ins. under low water level. The work was started in the early fall of 1917 with excavation for the crib.

It was our original intention to build a cofferdam around the location of the crib and then build the concrete crib right

in place on its pile foundation. Consequently the contractor built the cofferdam of 3-in. plank in three layers, so that the two outside layers covered up the joints of the center sheets. It was then covered with canvas on the pressure side and banked up with dirt to about half its depth. Rigid framework braced the wall from the inside.

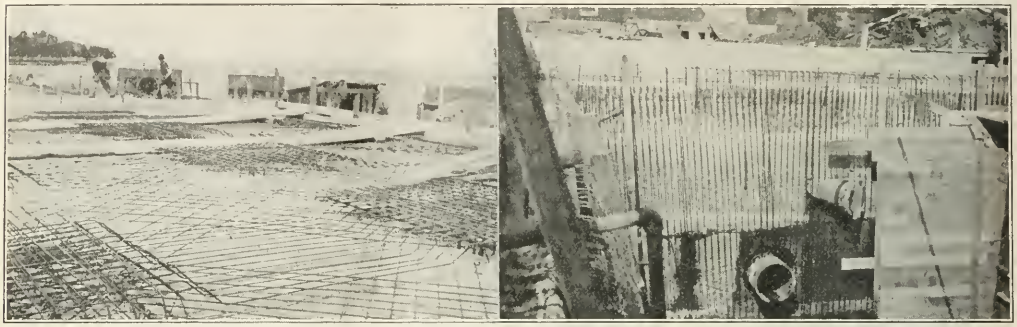
The sheet piling was driven to refusal in quicksand mixed with clay. Upon pumping out the cofferdam we discovered that the bottom would not hold, as the water broke through, carrying with it sand, thereby making it impossible to keep our excavation low enough for the bottom of the crib. After driving another cofferdam round the first one, with even a deeper penetration, we were not able to maintain our excavation. In order to eliminate the upward water pressure on the bottom inside the crib and to enable us to maintain our excavation, we filled the cofferdam and excavated to the proper elevation with the dredge, after having removed the inside bracing, that interfered with the excavation.

Crib Construction Difficulties Solved

We then proceeded with the construction of the crib on top of the cofferdam by placing stringers supported by the sheeting and laying a solid floor of 6-in. timber, upon which we built the forms for the crib, placed the reinforcement and the necessary castings and poured the concrete. After the crib was completed we lowered the entire crib, which weighs about 30 tons, with six threaded rods, supported on nuts, which again were supported by heavy timber horses. The operation of lowering this weight was very simple, merely unscrewing the nuts evenly on all six rods until the bottom of the crib struck the pile foundation.

The fact that we constructed the crib on top of the cofferdam made it less expensive to construct and gave us a better job than we could have expected inside the cofferdam. By the time the crib was completed the ice came, covering up the entire lake. As the city was in urgent need of this intake, we started to lay the pipe from the ice; that is, we located our dredge at the shore point of the line and kept a channel open sufficiently far ahead for our progress. As the pipe is practically level, we had about 12 ft. excavation next to the shore, gradually diminishing to about 2 ft. next to the crib. The pipes were lowered in sections of three and four lengths, with all joints that were made on shore of poured lead and the joints made under water were caulked with lead wool, with the exception of the flexible ball joints, which were flanged.

The advantages we observed by placing the line from the ice were that we were independent of weather conditions and the rough lake on windy days and that no extra barge was required for the handling of the pipe, as the pipe sections were hauled out on the ice and placed alongside the channel, where they were picked up by the dredge boom and lowered



VIEWS OF REMODELED RESERVOIR OF OSHKOSH WATER WORKS.

Left: Reinforcement in Flat Slab Roof Over South Reservoir (Old Settling Basin). Right: Formwork for Lining in North Reservoir with Triangle Mesh Reinforcement.

VIEWS OF REMODELED RESERVOIR OF OSHKOSH WATER WORKS.

Left: Construction in Progress in North Reservoir (Old Storage Basin). Note Dowels in Old Wall and Baffle Wall along Center Line of Reservoir. Right: Interior View of Old Settling Basin After Being Roofed and Ready to Store Filtered Water.

into the excavated bed. The contractor managed to reduce his cost of keeping the channel free from ice by cutting the ice and selling it to a local ice company.

Where the pipe line connects to the crib there is a 24-in. valve, and this was closed during the final tests. These tests were conducted by putting the entire line under a pressure of 30 lbs. per sq. in. from an elevated tank in the filter plant. A 10-in. pipe is connected from the riser pipe to a point on the intake immediately outside of the suction well in the filter plant, into which the intake discharges.

After having put the line under pressure several times for the purpose of discovering any leaky joints, which were recaulked, we finally got a perfectly tight job holding a pressure of 30 lbs. per sq. in. At the acceptance of the crib and intake the writer put on a diving suit and inspected the line and the crib.

Remodeling of Old Reservoir for Increasing the Storage Capacity of Filtered Water

At the time the new filtration plant was contemplated contracts were also let to remodel and cover up two storage basins which were used by the old water works, one for clear water storage and one for a settling basin. Their respective capacities are 1,300,000 gals. for the clear water basin and 700,000 gals. for the old settling basin.

The basins were both in a very poor condition, with cracked concrete walls without reinforcement. However, they were heavy enough to withstand the water pressure as a gravity wall. The work started first on the old settling basin, which was the worst of the two, and about 2 ft. lower than the other basin.

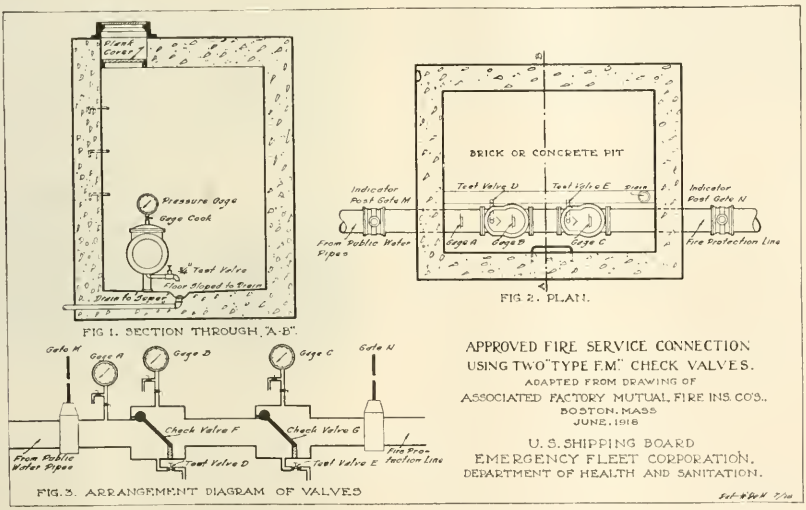
This is now completed and filled with water, while the work on the other basin is still under construction. The inside face of the walls was stepped off in four steps and the depth of 14 ft. was increased to 17 ft. To put these walls in a water-tight condition we gave the entire surface a 6-in. concrete lining, with heavy triangle mesh reinforcement. Dowels were placed in the walls about 4 ft. apart, also on top of the old walls. The concrete mixture in this lining was 1 part cement, 2 sand and 4 of roofing gravel mixed with smaller size crushed stone. The lining reinforcement was bent over at the top extending up to the height of the extension of the wall, which was poured in conjunction with the lining.

The roof of the basin is supported by columns about 16 ft. centers, and is of flat slab construction. Baffle walls were poured in between columns for the purpose of maintaining circulation of the water at all times and eliminating all dead space. The old piping is used and so arranged that each basin can be used independently. In the roof are placed manholes and ventilating shafts covered with a casting. As both basins are going to be covered with 1 ft. of dirt, the ventilating shafts are elevated to about 4 ft. over the top of the roof. The same construction method is now being used for the other basin.

As the floors were in poor condition, an extra 4 ins. of concrete was placed, reinforced with light triangle mesh. When the reservoirs are completed the earth level around the new filtration plant extended over the two basins will entirely conceal them, and at the same time will aid in keeping the water supply of the city cool in the summer.

Plans and Specifications for Dual Connections

The plans and specifications for dual water service connections given herewith are those of the Department of Health and Sanitation of the Emergency Fleet Corporation, of which Lieut. Col. Philip S. Doane is director and W. L. Stevenson is sanitary engineer. This department was created for the purpose of performing the same functions toward the shipyard workers as a state board or department of health per-



forms toward the citizens of a state, a bulletin was prepared by the department giving standards of practice. What follows is from the bulletin:

As the purity of the water supply is absolutely essential to health, there should not be any connection between the mains or pipes carrying drinking water and those carrying unpurified water used for industrial purposes or for fire protection.

In case unusual conditions indicate necessity for dual connections and if such be authorized by the Department of Health and Sanitation and approved by local and state health officials having lawful jurisdiction in the premises the same shall consist of two check valves, three pressure gauges and two blow-offs, installed in a manhole of ample size for convenient operation provided with a drain to carry away water blown off during tests.

The specifications for these check valves must require the seat ring, disc, holding ring and screws, disc stud, arm hinge pin and bushings to be of bronze; disc to be faced with me-

dium hard rubber, and that liberal clearances shall be left around clapper and arm in all positions.

This type of "fire service connection" is shown in the diagrammatic illustration. Normally, indicator post gate valves M and N are open and test valves D and E are closed. At monthly intervals a test should be made of the tightness of the check valves, and at intervals of about three months the bonnets of the check valves should be removed and the checks and their bearing seats carefully cleaned. To facilitate removal of bonnets, manilla paper packing, soaked in machine oil, should be used and bolts greased with heavy oil and graphite. To make test of lightness of check valves, close valve M and open valve D. Pressure on gauge A should fall to zero and on gauge B hold. Valve E should now be opened and pressure on gauge B should fall to zero and on gauge C hold. The principle of this test will be clearly seen by examining Figure 3 of the drawing. After test is completed valves M and N must be left open to permit flow through the connection.

City of Detroit Offsets Labor Shortage by Using Machinery for All Water Main Construction

Public service officials who have essential water or gas pipe lines to lay are confronted with the same obstacle that exists in all fields of construction—labor shortage. The result of this condition is a large increase in the use of machinery for excavating trenches, handling pipe, caulking joints and backfilling and tamping trenches.

The experience of the Board of Water Commissioners of the city of Detroit is probably typical of that of many of these public utility officials who turned to machinery when they found their work hampered by the scarcity and high cost of labor. The Detroit water commissioners not only overcame the labor difficulties but at the same time vastly speeded up their work by the use of machinery.

The Machinery

They now own and operate the following machines: Four Austin trenching machines, two Buckeye trenching machines, three Austin backfillers, two Oshkosh backfillers, one Wonder "Double Quick" backfiller, two Bucyrus cranes, one Chicago pneumatic compressor, and one Buckeye concrete breaker. These machines represent a total investment of about $40,000. A few of these machines were purchased late in 1916 and in the spring of 1917 and were utilized during a portion of the year 1917 with the result that the total of water mains laid exceeded that of any year in the history of the board. During the present year machinery has entirely replaced hand labor.

Accurate records have been kept of each day's work of each machine. The records of the trenching machines are particularly interesting as they tend to show that any public-service engineer who says he can excavate pipe line trenches more cheaply by hand than by machine must have had experience only with hand excavation.

Machine Performance Data

A Buckeye gasoline ditcher dug 28,234 lin. ft. of trench for 6 and 8-in. pipe in the first six months of 1918 at an average cost per foot of 4.7 cts. Working on trench for 12-in. pipe, an Austin gasoline ditcher during the same period dug 18,112 lin. ft. of trench at an average cost per foot of 5.7 cts. A large type Austin gasoline ditcher excavated 5,528 ft. of trench approximately 6 ft. 4 in. wide and 12 ft. deep at an average cost per foot of 26.8 cts. Another Austin ditcher of the same type, but operated by steam, dug 6,481 lin. ft. of trench for 48-in. pipe at an average cost of 31.2 cts. per ft. Considerable of the work of the two large machines was done during January, February and March, when they had to cut through ground frozen to a depth of 2 to 3 ft.

NON-TRACTION TYPE OF SMALL BACKFILLER.
One of these Wonder "Double Quick" Machines Backfilled 14,986 Lin. Ft. at Average Cost of 3.1 Cents per Ft.

THIS IS HOW LARGE PIPE IS HANDLED.
Bucyrus Steam Shovel-Cranes Replace Derricks for Stringing and Lowering Pipe.

Wages and Cost Accounting

These costs include everything connected with the operation and maintenance of the machines, viz: wages of opera-

THREE OF THE MACHINES USED ON DETROIT WATER TRENCH CONSTRUCTION. AT LEFT IS AUSTIN TRENCHING MACHINE WORKING ON TRENCH 6 FT. WIDE AND 12 FT. DEEP. THE MIDDLE VIEW SHOWS AN AUSTIN BACKFILLER. THE VIEW AT RIGHT IS A BUCKEYE MACHINE USED ON DITCHING FOR 6 AND 8 IN. PIPE.

tor and assistant, cost of moving to job and from one job to another, cost of repairs, gasoline (or coal), oil, overhead and depreciation. The cost of maintaining two mechanics to look after all the machines is charged to overhead and split up among the productive machines which are out on the various jobs; for instance, if these two mechanics are costing $20 per day and ten machines are in operation on a certain day, $2 will be charged against each working machine as "overhead" for that day.

Depreciation is figured at so much per lineal foot of trench excavated, varying from ½ ct. per ft. for the smallest machine up to 2 cts. per ft. for the big Austin machine used on trench for 48-in. pipe. This is not offered by the Detroit department as an absolutely accurate way of figuring depreciation, but it seems like a fair solution. The trenching machine operators are now paid 85 to 90 cts. per hour and the assistants 50 and 55 cts. per hour.

Only good mechanics are employed as operators and they are expected to keep their machines in first class shape.

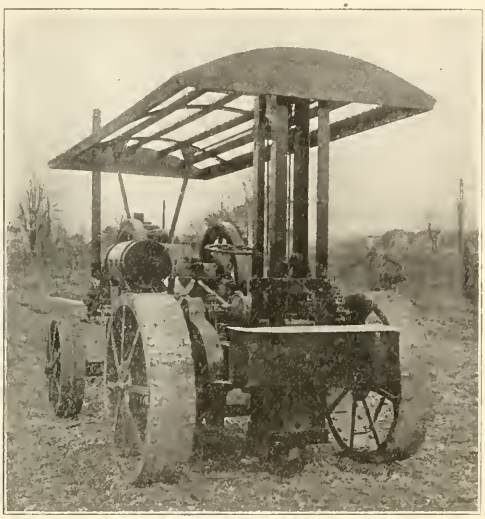
SOMETIMES CONDITIONS WERE IDEAL.

But this same machine also worked right through the winter when ground was frozen. It is an old type Austin Backfiller Without Caterpillar Traction.

When a machine is idle for a day or so between jobs the operator is expected to put in his time carefully looking over the machine, and this is charged to repairing instead of operating cost. If a machine is to be idle for a longer period the operator comes in and makes himself useful in the stock room or repair shop at the main storage yard of the Board of Water Commissioners.

Performance of Backfillers

All the trenches this year have been backfilled by machine and at very low cost. The three light backfillers used on small ditches showed average costs for the period from January to June, 1918, of 3.1, 3.3 and 3.6 cts. per lin. ft. of trench backfilled, the lowest cost being credited to a non-traction type Wonder "Double Quick" machine manufactured by the Waterloo Cement Machinery Corp., of Waterloo, Ia. The large ditch backfilling, as well as a portion of the small ditch work was handled by three backfillers of the boom type manufactured by the F. C. Austin Co., Inc., Chicago. Two of these



"BUCKEYE" CONCRETE BREAKER.

Very useful when Trenches have to be Cut Through Pavements.

machines were mounted on round wheels and one was a late model equipped with caterpiller traction which handles much easier than the machines with round wheel traction. One of these Austin backfillers which was used on both large and small ditches and contended with frozen soil on some jobs, backfilled 16,525 lin. ft. at an average cost of 4.6 cts. per ft. The costs for the backfillers were figured the same as for the trench excavators except that the depreciation charges were ½ ct. per ft. of trench backfilled for the small machines and 1 ct. per ft. for the large machines. Backfiller operators received 50 to 60 cts. an hour, depending upon the size of the machine.

Handling Pipe

Bucyrus steam cranes are used for loading and unloading pipe and lowering large pipe into trenches. The board owns two of these machines. In stringing and lowering pipe they are much safer and cheaper than the old style derricks which

THE DETROIT WATER COMMISSIONERS USE TWO OF THESE OSHKOSH BACKFILLERS ON SMALL TRENCHES.

they replace. One of the cranes is equipped with combination crane boom and dipper stick and is readily converted into a steam shovel by attaching a dipper.

Caulking Joints

A Chicago Pneumatic Tool Company air compressor does all the caulking on large pipe, replacing the gang formerly required for this work. In the six-month period, January-June, 1918, it caulked 738 joints of 48-in. pipe at a total cost of $837.88, including labor of operator (who received 60 cts. an hour), moving and repair cost, oil, gas, overhead and depreciation. In joining small ppe "Metalium" was used. This is a metaloidal alloy manufactured by the Metalium Refining Co., Omaha, Nebr. It requires no caulking.

Concrete Breaker

An interesting machine, the Buckeye Concrete Breaker, is being successfully used where trenches have to be cut through pavements. The machine breaks up the asphalt or

THE EMERGENCY REPAIR FLEET.

concrete pavement ahead of the trench excavator, and has done very valuable and efficient work. It is a product of the Buckeye Traction Ditcher Co., Findlay, Ohio.

Motor Truck Fleet

Loss of time due to breakdowns has been reduced to a minimum by the methods adopted. One of the accompanying illustrations shows the emergency fleet of automobiles which is ready at all times at the storage yard to answer a call from one of the jobs. In addition, there is a 5-ton Packard truck equipped with lathe, drill press, grinders, air compressor, forge, etc. A complete stock of parts for all machines is carried in the repair shop at the storage yard.

The whole story of how speedily and economically Detroit has laid its largest annual mileage of water pipe during a period of critical labor shortage, cannot be written until com-

DIGGING TRENCH IN LOOSE CAVING SOIL.
This shows some of the Difficult Work Handled Satisfactorily by the Detroit Machines. Austin Ditcher in the Distance.

plete cost figures are available. Enough has been set forth here, however, to make clear the part that machinery had in the accomplishment. The author is indebted for most of his information to Mr. L. J. Clancy, assistant general superintendent, and Mr. Edward Frey, supervisor of machines, of the Detroit Water Works Department.

WATER PURIFICATION AND SEWAGE TREATMENT

Sewage Treatment Policies as Influenced by War-Time Conditions

By George W. Fuller, Consulting Engineer, 170 Broadway, New York, N. Y.

The stress of war conditions has brought to the front several viewpoints concerning municipal sanitation which are worthy of most careful consideration. Some of these have been well outlined by Messrs. Kenneth Allen and T. Chalkley Hatton in recent issues of this journal. Others have arisen for discussion by sanitary engineers and mention may be made of the following:

War-Time Considerations

1. Shortage of funds, materials and labor, means that for a term of years money devoted to public health work should be spent so that the return per dollar of investment will be as high as practicable under the new conditions when viewed both in absolute and relative terms.

2. The large army camps, particularly in the Southern States, have revived the question of transmission of diseases by insects, and sanitary engineers unquestionably must renew their efforts to become familiar in a practical way with insecticides and other lines of work of the entomologist.

3. Recovery of grease from kitchen wastes at army camps is a practical proposition, both with respect to conservation of fats and the bearing which the undertaking has on the composition of sewage in relation to treatment and disposal.

4. High prices and shortage of farm labor mean that more attention to fertilizers should be given in farming operations, and this, in turn, should stimulate increased attention, not only to activated sludge, but to the recovery of plant foods from sludges obtained from coarse-grained filters and other sources.

5. Factors of safety should be considered anew for sewage treatment procedures, not only from the standpoint of seeing that money is spent where there is urgent need for treatment

plants that will do the most good per dollar of cost, but also that the operating procedures are commensurate and adequate at those seasons of the year and under varying local conditions, in the interest either of the public health or avoidance of gross nuisance, or both. Perfunctory adoption of sewage treatment procedures for twelve months in the year is not necessarily wise, as there are many cases where there is real need of effective sewage treatment during the bathing period, but where during the winter months disposal of raw sewage will do far less harm than indifferently operated treatment works during the summer.

All these subjects could be discussed at great length. It is not the intention in this brief article to do more than explain the general viewpoint in hope that sanitary engineers, particularly those interested in sewage disposal, will recognize that they have responsibilities in adjusting their technique to the new regime of affairs incident to the role which every one must now play as a result of the world war.

Where Will Investments in Sanitary Works Do the Most Good?

American municipalities for years have shown a fondness for proceeding in a hit-or-miss, or perhaps rule-of-thumb, method in handling sanitary problems. As to sewage disposal, it has been the vogue to defer investments until the courts or state departments of health have forced the issue, and then to show an unfortunate tendency to get but little return on the plant investment in consequence of indifferent operation.

For some years a better state of affairs has been developing as a result of city planning along various lines of municipal investments, and annual budgeting has caused more and better attention in some cities to be given than hitherto to operating city owned works efficiently.

Municipalities, like individuals, must now economize. Earlier custom should no longer be accepted without investigations as to adjustment to the new conditions. Practical deductions must be made as to the significance which current evidence produces, and studies must be made to record anew the procedure which is best for all municipal departments.

Sanitary problems must be considered in the light of whether in the past money has been spent in ways which do not now give as good a return in the interest of the public health as would develop along other channels. We must face anew the problem of where a dollar will do the most good in the interest of the public health. Sewage disposal is only one of the branches of municipal sanitation. The whole question should be reviewed from the standpoints of investment and operating expense in relation to the needs for each city in this particular line. And such results should be weighed most carefully in comparison with investments and upkeep needs along other lines in the sanitary field.

Insect Control

Since the days of the Spanish-American war, and before that time, the sanitary engineer has known of the general importance of insects in the transmission of disease. He has been interested in mosquito elimination and knows that sprinkling filters have caused at times an unusual prevalence locally of certain kinds of flies. At some plants this has been a real item for consideration. At other such plants flies seem to have been under control almost without exception, apparently due to the influence of other forms of life.

Appreciation of how flies thrive in some kinds of sewage sludges, and in the materials accumulating as films upon sprinkling filters of coarse material, shows that the engineer must apply himself to the practical study of the work of sanitary inspectors and entomologists. No longer can he be unfamiliar with insecticides as applied to suit his treatment procedures. Measures to control flies in relation to city garbage and to handling of stable manure are not necessarily applicable to the problem at a sewage disposal plant.

Practical knowledge of means of preventing or of killing flies must be acquired with more thoroughness by the sanitary engineer than has been the case hitherto. In particular must he familiarize himself with arrangements involving structural modifications of treatment plants, to the end that insects may be kept under proper control.

Flooding of sprinkling filters to kill moth flies by drowning, as is the case with contact filters, is a good illustration. This comes from the current work of Dr. Thomas J. Headlee, State Entomologist of New Jersey, in advising upon fly control at the sprinkling filter plant at Plainfield, N. J. In the course of this work studies have been made of the relative efficiency of different insecticides applied in different ways. Along these lines the technical operators of sewage treatment plants should at once become more proficient in the application of their practical knowledge.

Grease Recovery

At some of the army camps abroad grease from kitchen wastes is recovered and the proceeds from the sale thereof are applied to the mess fund. This is not necessarily the wisest policy to follow literally, but it does suggest for this country a phase of conservation that should receive more study than has been the case hitherto. At army kitchens the recovery of waste discharged through the sinks is, of course, more easily handled than is the recovery of grease from municipal sewage. However, this whole question is assuming new significance from several different angles and the sanitary engineer should not lag behind in his utilization of such knowledge.

For some time the disturbing influence of grease at sewage treatment plants has been appreciated. At institutional plants the benefits of grease recovery, in relation to subsequent treatment of the sewage, have been pronounced in some instances. As the problem has extended into the municipal field complications have arisen, as the value of the grease is less after it has been mixed with the sanitary wastes than when recovered from the kitchen drains without admixture with fecal matters.

As the problem broadens to include its relation to municipalities, where sewers contain industrial wastes, oils and fatty matters not readily suitable for grease recovery, new factors add their complicating influences, as compared with the kitchen drains at army camps. Because the sanitary engineer is not now well posted on the recovery of grease and fats is no reason why, as opportunity presents, he should not bend his efforts towards solving this type of problem where feasible.

Recovery of Fertilizing Elements

It is not the intention here to go into the value as plant food of activated sludge or sewage matters incident to other lines of treatment. The idea suggests itself forcefully that, with the present prices and shortage of labor, the fertilizer trade is likely to look in the future with more, rather than less, favor than it does now upon sewage matters in a form usable as plant food.

In passing, the comment may be made that the sludge from secondary tanks receiving the effluent of sprinkling filters is a product which farmers themselves have learned is a better fertilizer than is ordinary tank sludge. Farmers readily seek the material detached from stones found in waterways in which flow the effluent of coarse stone filters, and also the deposits settled from water used in washing clogged filtering material. This product is known in England as "slurry."

For sizable projects it is believed that this material should be considered as a fertilizer product, particularly as it is known that chloride of lime and other chemicals applied to coarse stone filters may bring about almost at will the detachment of the films on the filtering material. The problem for the sanitary engineer is to see how best to do this without destroying the films so completely as to interfere with the efficiency of the filter. The problem of freeing this product of water resembles that in the activated sludge process, and ef-

forts made to control odors should be along the foremost lines of investigation in the field of garbage disposal and odor-producing industries.

Factors of Safety

The mere fact that a community installs a sewage treatment plant does not necessarily have much, if any, sanitary significance. It is quite possible that accomplishments may transfer a nuisance from bodies of water to a nuisance on land, or result in both complications at the same time. If sewage treatment is really worth while, if for only three months during the year, it is better to see to it that this result is actually accomplished effectively for such a period than to allow the plant to be operated indifferently throughout the year, so that communities obtain a false sense of security. The economics of these problems, including capital charges, operating expenses, benefits really secured, with consideration given to direct and indirect damages, should be recomputed in the light of present knowledge.

Factors of safety should be studied in relation to the real need of sewage treatment, and accomplishments should be weighed in percentages of actual efficiency along sanitary lines. The mere name of an actual installation does not mean that sewage treatment is practiced with a due regard to a sound sense of proportion. Such judgment should be exercised, and if sewage treatment is not ordinarily necessary steps should be taken accordingly. Correspondingly, if sewage treatment is needed for a limited portion of each year, as has been actually found to be the case at a number of places in this country, this marks the procedure which should be followed out. If sewage treatment is needed all of the year, then a plant should be built adequately both as to type and size and operations conducted so that real safety is obtained.

There is just as much sense, and perhaps more need just now, in applying factors of safety to sewage treatment problems as to dams, bridges and buildings.

It is not the intention in this article to imply that engineers dealing with sewage treatment problems are the only ones who should take account of stock as to their broad technical procedure. All engineers face that responsibility, and have been moving in that direction with more or less speed for some time. All engineers are facing extraordinary responsibilities, incident to war conditions, and the sanitary engineers must do their full share.

Sanitary Precautions Taken Prior to Opening Wilson Avenue Crib and Tunnel of Chicago Water Works

By John Dill Robertson, M. D., Commissioner of Health, City of Chicago, and Herman N. Bundeson, M. D., Director of Field Force

Before describing the sanitary precautions taken prior to opening the Wilson Avenue Crib and Tunnel of the Chicago waterworks, it is well, for the sake of securing the proper perspective, to give in brief, statistical form certain essential information relative to the design and constructional features of the works:

Statistical Information

Preliminary work started April, 1913.

Tunnel started at Shore Shaft September, 1914.

Drifts 7 and 8 met, December, 1915.

Drifts 3 and 4 met, September, 1916.

Drifts 5 and 6 met, July, 1917.

Drifts 1 and 2 met, September, 1917.

Diameter of tunnel 12 ft. from Mayfair to Lake View Crib, 7 miles.

Diameter of tunnel 13 ft. from Lake View Crib to Wilson Avenue Crib, 1 mile.

Lowest point in tunnel: 140.8, shore shaft.

Highest point in tunnel: 97.0, meeting point of drifts 3 and 4.

Maximum monthly progress tunneling in one drift, 630 lin. ft., normal per drift 564 ft.

Maximum monthly progress concreting from one shaft 2,175 lin. ft., normal per shaft 1,178 ft.

Maximum daily progress tunneling: 28 lin. ft.; normal daily progress: 22 ft. per drift.

Maximum daily progress concreting, 60 lin. ft. per drift.

At a velocity of 4 ft. per second the 13 ft. tunnel carries 346,000,000 gals. of water per 24 hours.

The Lake View Pumping Station uses 100,000,000 gals. per day. The Mayfair Pumping Station will pump 152,000,000 gals. per day, which leaves a surplus of 94,000,000 gals. for future extension.

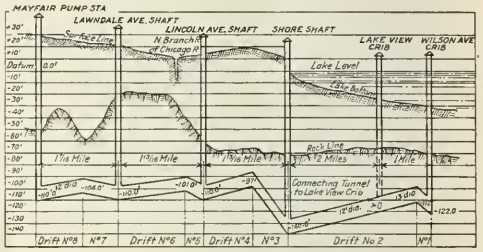
Excavation in 12 ft. dia. tunnel per ft. 6 cu. yds.

Excavation in 13 ft. dia. tunnel per ft. 7 cu. yds.

Number of bags of cement used, 865,420.

Number of one yard cars of excavated loose rock, 517,440.

Number of average trains of 25 cars each, 20,696.



PROFILE OF WILSON AVENUE TUNNEL OF THE CHICAGO WATER WORKS.

Saving of time by using tunnel rock for concrete: eleven to twelve months.

The lake end of the South West Land and Lake Tunnel, built by contract, 12,180 ft., 2.30 miles long, and using an intermediate crib, required four years and nine months to complete.

The lake end of Wilson Avenue Tunnel, built by City day labor from Shore Shaft, 14,850 ft. 2.81 miles long, without intermediate crib, required three years to complete.

The estimate for Wilson Avenue Tunnel and Intake Crib was $4,550,870. There was spent up to Dec. 31, 1917, $3,609,-132.97. Appropriation for 1918, to complete the work, $450,-000, leaving a balance of $491,737.03.

Lake View Crib Connection.

By a daring piece of engineering the Department of Public Works arranged to supply the Lake View Pumping Station with water from the Wilson Avenue Crib, thus getting a purer supply and saving the cost of operation and maintenance of the Lake View Crib.

At a distance of two miles east of the Shore Shaft an 8 ft. tunnel was driven from the Wilson Avenue Tunnel to a point under the shaft of the Lake View Crib, thence upward to within 10½ ft. of the bottom of the shaft, and a cast steel bulkhead was placed in the vertical section.

After the Mayfair pumping station was placed in operation the shaft of the Lakeview crib was extended downward to the steel bulkhead, the removal of which established a connection between the Lakeview and Wilson avenue tunnels.

Sanitary Precautions

Before the Mayfair pumping station was placed in operation the floor of the tunnel was liberally sprinkled with chloride of lime, which was allowed to remain there for several days.

In addition to this, after the pumping station machinery was started, the water was chlorinated at the pumping station and was then directly discharged into the sewers for three weeks. At this time the engines were pumping approximately 30,000,000 gals. per day.

Sanitary regulations were formulated under which the use of the crib as a water intake might be permitted to operate while construction work was still in progress, as follows:

1. That a chlorination apparatus be also installed at the crib for treatment of the water as it enters the tunnel shaft.

2. That a sanitary inspector be detailed by the Department of Health to the crib until construction work is completed. The sanitary inspector should be charged with the enforcement of sanitary regulations and should report to the director of field force in charge of city water with respect to infractions of rules and other difficulties encountered.

3. That the incinerators be placed in completely inclosed compartments. That one incinerator be used for fecal matter and that other incinerators be used for urine and for wash water. That the practice of discharging urine and throwing water into the coal pile be discontinued.

4. That cuspidors or pails containing chloride of lime solution be provided as receptacles for expectoration. That the contents of the cuspidors or pails be disposed of by emptying into an incinerator.

5. That signs be posted about the structure prohibiting employes or visitors from expectorating or disposing of any body secretions except into the receptacles provided.

6. That a supply of chloride of lime be kept at the crib at all times. That the floors be sprinkled with chloride of lime at frequent intervals. That chloride of lime be placed in all cuspidors and in all receptacles containing waste water. That the coal pile be treated with chloride of lime for several successive days after discontinuance of the present method of waste disposal.

7. That all employes be required to submit suitable specimens of urine and feces to the Bureau of Laboratories for typhoid examination.

(a) That present employes submit specimens as soon as practicable.

(b) That new employes submit specimens as soon as employed.

(c) That the names of all absentees among employes be reported daily by the sanitary inspector to the director of field force for investigation as to causes of illness.

8. That water samples for examination by the Bureau of Laboratories be collected daily from the Mayfair and Lakeview pumping stations until such time as the construction work at the crib is completed. That, pending completion of construction work, daily samples be collected by the sanitary inspector at the crib, except on days when samples are taken by the regular water sampler.

9. That the Mayfair pumping station shall not be placed in service until the aforesaid recommendations be complied with, and until it is found that the water at the station is safe. To this end, samples of water were taken at hourly intervals during the course of the day.

The feasibility of these precautions is demonstrated by the fact that of the men examined at the crib, one turned out to be a paratyphoid fever carrier, and should his dejecta have gotten into the distributing system, it might easily have caused an epidemic of paratyphoid fever in Chicago.

The Department of Public Works is to be congratulated upon insisting that a sanitary survey be made of all water tunnels, etc., before being placed in operation.

Recent Development in Equipment Used in Ozone Method of Water Treatment

By Irwin D. Groak, Consulting Engineer, Monadnock Block, Chicago

Since the discovery of the germicidal action of Ozone it has caused great activity in the scientific and engineering field; the results are many successes, and some failures. The generation, control and direction of ozone for the purification of water requires special engineering skill and practical experience, but it has been scientifically and definitely demonstrated that ozone completely destroys bacteria in water.

It is claimed by scientists, with whom the writer personally discussed the subject, that in the O_3, when the nascent oxygen is given up, that is when ozone breaks down into oxygen,

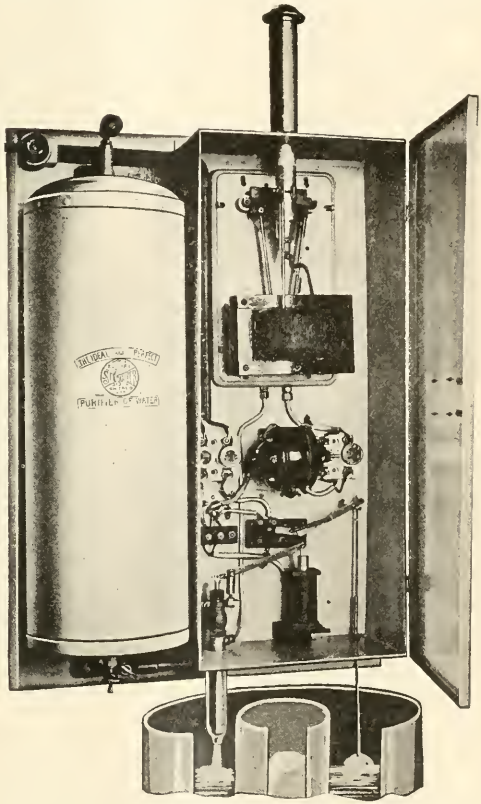


FIG. 1. AUTOMATIC OZONE WATER STERILIZER FOR USE ON SHIPS.

that not only one part of oxygen is acting on organic matter, but all three parts so act. This phenomena might be an explanation for the powerful action with which ozone attacks carbon, burning it up in the CO_2 and, after all, bacteria are nothing but carbon and water. Relatively the density of water to air is 1,000 to 1, and it requires one gramm of ozone diluted in one cubic meter of air thoroughly mixed with one cubic meter of water to make that water safe for drinking purposes, by destroying all the pathogenic bacteria. This is the average. In some cases less, and in others more ozone is required depending on the organic impurities or vegetation in the water.

Physical Improvement of Ozonated Water

Ozone is the only gas known today which if mixed with

water thoroughly in the proper concentration and quality will not only destroy all the pathogenic organisms, but will also take out the color, odor and taste due to organic impurities, producing a hygienically and physically desirable drinking water without any residue of the chemical left in the water, and without materially changing the mineral or inorganic quantities.

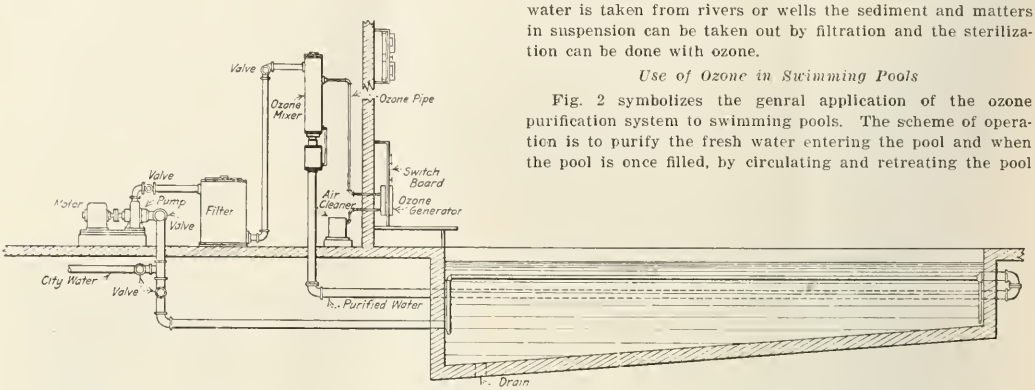


FIG. 2. DIAGRAM ILLUSTRATING THE GENERAL APPLICATION OF THE OZONE WATER PURIFICATION SYSTEM TO SWIMMING POOLS.

The problem before the engineer is the economical production of ozone by electrical brush discharge, and the design and application of it to meet different requirements.

Three New Ozone Machines

The Electric Ozone Sterilizer Company of America, Monadnock building, Chicago, are putting on the market three new machines. Fig. 1 is a view of a direct current ozonizer. As high frequency is required for the brush discharge about 6,000 volts are employed. It is stepped up from the original lighting circuit. Where alternating current is not available a rotary conveyor or motor generator set can be applied.

Ozone Water Purification for Use on Ships

Fig. 1 shows an electric ozone sterilizer machine entirely automatic in its operation, and of the suction type. The capacity ranges from 25 to 60 gallons of water per hour. For larger sizes the pressure type is recommended.

The operation is controlled by a float. The position of the float is determined by the height of the water in a reservoir. When the water supply is low the making of electric contact closes the circuit and brings a magnet into operation. This opens the faucet or mixing valve. The untreated water comes under pressure of 15 to 25 lbs., going through the mixing valve into an aspirator, creates a vacuum which causes suction, and the ozonized air from the generator passes into the water and is thoroughly mixed in the mixing chamber underneath the valve.

After the water reaches a predetermined volume, which is governed by the position of the float ball, the electric circuit is opened automatically, stopping the action of the ozonizer. Inside of the reservoir a cooling arrangement is provided either for ice or other means of refrigeration, as available.

This machine takes very little space. Without the reservoir it is about 22 ins. wide, 32 ins. high, and 10 ins. deep. It was designed to be used on ships where good drinking water is appreciated and needed. Passengers on a ship are dependent on a stored water supply, the purity of which is always in question. Electricity is available on every ship, and the quantity needed for purifying the drinking water is less than that required to light a small electric light bulb. This improvement means much to travelers, especially in war times when it is essential that the health of troops shall be kept at the highest attainable point.

Similar apparatus is designed to be used on ambulances and automobiles and hand carts for portable equipment. In this case a pump and filter is added so that in case the water is taken from rivers or wells the sediment and matters in suspension can be taken out by filtration and the sterilization can be done with ozone.

Use of Ozone in Swimming Pools

Fig. 2 symbolizes the genral application of the ozone purification system to swimming pools. The scheme of operation is to purify the fresh water entering the pool and when the pool is once filled, by circulating and retreating the pool water, it can be kept safe for the swimmers. There are many impurities to contend with, most important of which are from the bathers' bodies and clothes. Some of this matter can be taken out by filtration; therefore a centrifugal or piston pump keeps the water in circulation from the pool through a filter. After passing the filter the water flows through the ozonizer and back again into the pool.

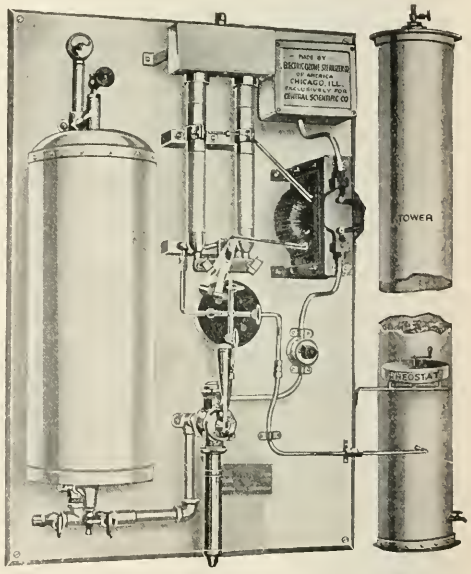


FIG. 3. LABORATORY TYPE OZONIZER FOR EXPERIMENTAL PURPOSES.

Three different methods can be applied and are recommended by the Electric Ozone Sterilizer Co. First, where the

ozonized water enters the pool at one place and the raw water or untreated water is taken out from the opposite end of the pool. Second, where the ozonized water flows into the pool from small holes arranged in a pipe alongside the wall of the entire pool. This method is more effective than the first. Third, where the ozonized water enters the pool from pipe nozzles laid under the bottom of the pool, carefully distributed. The third is the most effective of all, because the ozonized water carries a considerable amount of ozone which will help purify the water in the pool itself. The surplus ozone coming to the top of the water deodorizes the peculiar smell of the water and air on top of the water. It is not necessary to circulate all of the time, but as required.

The ozone purification of swimming pools is a paying proposition, besides being a health insurance. The reason for this is that it is cheaper to refilter and reozonize the water, than to buy fresh water and heat it; thus it helps in saving the coal supply.

Experimental Laboratory Equipment

Another, and probably one of the most interesting ozonizers ever produced, is a laboratory machine, which can be used by colleges, institutions, and industries, also by municipal laboratories to determine the amount of ozone necessary for the purification of water, and the concentration of it. Fig. 3 shows this ozonizer equipped with two tubes, an aspirator, mixing valve, and tower, so that either the suction or pressure system can be used with one or two tubes. The concentration of ozone (the quality) can be regulated by diluting it with air, or by changing the voltage with a rheostat. The quantity can be measured from time to time, by the well known chemical method with potassium iodine. The air can be measured with an air-flow meter. This machine is marketed by the Central Scientific Company of Chicago and not only has its advantages in the laboratory for practical determination for large water purification plants, but it can be applied in many other industries where bleaching or rapid oxidation is required.

WATER WORKS MAINTENANCE AND OPERATION

Practical Measures for Securing Greatest Economy in Public Utility Plant Operation

By Charles Brossmann, Consulting Engineer, Indianapolis, Indiana

IV.—Instruments and Their Uses

Thirty years ago eggs were 15c a dozen. Now they are becoming a luxury. Thirty years ago a Ford would have been a luxury. Now you can hardly do business without one. Thirty years ago we had hopes of the submarine. Now we hate the sight of them.

Thirty years ago 15 or 20 lbs. of coal per k.w. was common. Today we are doing it on 5 lbs. and less in well-operated plants, according to size. And then coal was costing from $1 to $2 per ton. Now it is $4 to $6 per ton.

And it all goes to show that things certainly do change.

But some things change oftener and more radically than others. Improvements in power machinery have been gradual, necessarily so, as it is not possible to discard equipment each year as a new idea is introduced. But many concerns find it pays to tear out the old and put in the new, even at great cost. In such cases the saving and convenience must warrant it.

Bad habits or methods of doing things are not so easily changed as equipment, and in many cases can be changed only by a hard jolt. There are some habits or methods that are receiving some hard jolts at the present time, and the main reason is that the pocketbook is badly jolted also.

War Sharpens the Wits

I'll venture to say there has been more hard thinking about fuel economy by some plant owners and managers in the last year than in the 30 years mentioned at the start of this article.

Things in the past have been too easy. The South Sea Islander does not think of his next meal, because he has only to climb a tree and get it. Neither was it hard to get coal 20 years ago, or even 5 years ago, but now—. And that is the reason we are now thinking of such things as CO_2, when 20 years ago you would have been laughed at with your little analyzer.

College professors and mathematicians discussed higher economics then. Now the operating engineer and manager has his own instruments if he is progressive, and he can tell you something about economics. But the trouble is that not enough men realize what can be done by application and thought to the things that we formerly thought were not essential.

Introducing a Rational System of Operation

What a God send it would be if your old boiler would spit like a gasoline carburetor when you gave it the wrong mixture of air. It would be a little trouble, of course, but you would no doubt see that things were changed. One great trouble is that in all these little leaks they can get by unnoticed so easily.

Now, system is a thing often overdone. It is also something that you can't do without in some cases and places, and I am going to touch again on the question of proper firing and say that you should work out your best system and follow it, even if it is some trouble. Get yourself a scale for weighing coal and some means for weighing water or a steam-flow recording instrument and start with these, and as you become more interested, and, what is more important, as you get results, keep trying. Start a simple boiler and engine room log and keep track of the main items at first, and add to it and revise as it is found best. When you get your scales, start on your firing and investigate and try for your best condition—make note of the time between firings and number of scoops of coal, and all items that affect it, and you will notice changes if there is a chance for improvement.

The Necessary Foundation

If you have a regular load, such as most water works plants have, you will find certain conditions best to get the most economy. Find your best thickness of fire. Fire one side at a time and try with 5 or 6 scoops of coal, taking one door at a time. Get some timing arrangement, a bell to ring every 5 minutes, or the time necessary to cover all boilers according to number. If more than one fireman is required, let one work while the other rests, firing alternately, first all right-hand doors, then all left-hand doors. This is just a suggestion if you have never tried it, but the more uniformly you feed your coal and air, the better will be the results of combustion. Now, with your scales to weigh coal and your boiler room log sheet, you have your first simple recording instrument and

the necessary foundation to start things. Try and follow with the others. If you have a recording feed-water meter or steam meter, it now becomes easy to get the comparative results of evaporation, and that is your main object at the boiler—to turn the greatest amount of steam into water. With your records and means to find out, you can try out for the best methods of firing and you will notice the difference.

Operating the Boiler

Your boiler is a regular patient; its temperature and digestion are changeable; its temperature is up and down. Hang a chart at the bedside—you are the doctor, and you will get results if you watch both your patient and chart.

Some men feed a boiler with water regularly, a little at a time; some will give a big dose of water and wonder why the power drops. You can feed in large, sudden quantities, and your load will be quickly affected. Feed the water as uniformly as possible. The same holds good for the air—and all in proper quantities.

Blow the tubes or surfaces for soot regularly. Get a thermometer, one that will register 800 to 1,000 degrees, and try your stack temperatures after soot blowing, and see if there is a difference, and find out how often you should blow. You want all the heat you can get into the boiler, not out the stack, and keep a record of when the tubes are blown, so you will know that you did not forget it.

The firemen should understand that the purpose of any meters, recording instruments and the proper keeping of records are not for the purpose of criticising his work, but that they are to assist him in saving fuel and making his labor lighter. He should realize what it means if his boiler plant is using, say, 20 tons a day. If he saves 10 per cent he will cut out the handling of over 700 tons of coal each year and a goodly number of tons of ashes will not have to be wheeled. Have your records made so that a copy can be kept at the plant as well as at the office, and if your plant is large enough to get up interest between shifts, have a blackboard so that each crew can see what is being accomplished. Get the right spirit into the men

Power Plant Economy No Longer Optional

Remember also that you will have to look into these things. The government is taking a hand, and federal inspection of plants is a definite thing. A systematic classification has been started and is now under way and plants will be classified according to their efficiency and care used in operation. The ratings will be divided into five classes. The first one to suffer in a fuel shortage will be the waster of fuel, so to operate your plant inefficiently may be the means of closing it, as the one wasting fuel will be the first to have coal refused when the pinch comes.

This does not mean that you must install new and expensive apparatus, but you should place what you have in good condition and then see that it is operated properly.

Your boilers may be in fine shape, but you may be firing wrong; the tubes may be sooted up, or your blow-off valves may leak.

Your engines may be O. K., but perhaps a valve needs adjusting or a steam trap may be leaking badly.

You may have a good feed water heater, but perhaps your water temperature is 150 degrees when it should be over 200 degrees. See if the inlet and overflow are leaking.

Your condenser and air pump to your engine may be of the best, but perhaps you are getting only 23 to 24 ins. of vacuum when you should have 26. Look into it and find the trouble. See if you have a loose stuffing box on the L. P. rod or air leaks in the line. A mighty small one will kill the vacuum. I once had a bucket full of crawdads and fish heads taken out of the tube sheet of a surface condenser and they had blamed it all on the circulating pump.

In one plant a new stack had been built higher than the old stack and the old stack had been left connected to the other end of the breeching. The new boiler would not carry the load and it was blamed on the boiler. A draft gage would have shown the trouble at once, even if the owner had not known better than to think the two stacks would give better draft.

Instruments Are Indispensable

But what is the lesson of all these things. Simply this: that you can't tell what you are doing without instruments. In some cases simple indicating instruments and in some cases recording instruments. Some are more or less complicated, but it is impossible to get along and save without a certain number of them, which will be determined according to your operating conditions. You have a gage on your boiler. Why not a thermometer to measure stack temperatures? Why not one to record feed water temperature? If your feed temperature is 180 degrees and should be 206 to 210, have you ever considered what it means if you have exhaust steam to spare? If you are burning 20 tons of coal a day and with coal at $4 per ton, it is close to $500 per year. You could buy several recording thermometers for that, and you don't even need a recording one if you will watch a simple indicating thermometer at intervals.

Take the steam flow meter, for instance. If you have more than one boiler, get a meter for each boiler. How do you know each boiler is taking its share of the load? The meter will show you instantly and your fireman will then know when something is wrong. How else can he know?

I have seen several boilers operated where one with a slight overload would carry the whole plant and at better efficiency.

Every plant with an engine or pump should have an engine indicator, but I have known men to have them and not use them once in a year.

Instruments must be used and used intelligently, and the time should be taken to use them. Employes should be instructed and encouraged to use them to advantage, and the owner or superintendent or manager should instruct his men and get the results. Give your men the encouragement to use the instruments. Don't expect maximum results with minimum means for obtaining them.

No man can obtain the best results in economy unless he has, first, the desire, and second, the equipment. And it will take some thought and some work, but you will get back a great deal more than you put in.

Herewith is given a list of some of the important instruments used in the modern plant for assistance in fuel saving and the proper keeping of records.

Some Instruments Used for Procuring and Maintaining Maximum Efficiency in Power Plants—What They Record or Indicate and Other Useful Things They Show

Record steam pressure gages: Give continuous record of steam pressure; indicate indirectly firing condition.

Recording water pressure gages (for water works stations): Give continuous record of water pressure; indicate indirectly water conditions and steam conditions.

Recording and totalizing water meters, revolution counters (water works stations): Give actual record of water consumption. Meter readings will assist in showing up losses and large leaks in mains. Show increased consumption. Used in connection with revolution counter on pump, it will show condition of water end of pump and assists in timing slip, etc.

Recording graphic watt meter, totalizing watt meter (stations using electric power): Gives total electric load or current consumed. Used in connection with fuel scales; coal per k.w. can be determined. Proper records should be kept so that pounds of coal per k.w. does not increase without means being taken to find the trouble. The graphic meter also shows the load at each instant of the day—gives the peak and shows up any unusual condition.

Thermometer, stack: Gives temperatures of gases in rear passes and stack. Increase of stack temperature above normal may indicate accumulation of soot on shell or tubes. Decrease below normal may indicate excess air or holes in fire or leaky settings, or, indirectly, too large grate surface.

Orsat apparatus, hand flue gas analyzer for CO2 (carbon dioxide) readings: Shows combustion conditions in furnace by gas analyses. This is a very essential and useful device, used mainly to build up furnace efficiency. Indicates condition of furnace efficiency. Shows excess air conditions (each 12 per cent excess air above 40 per cent means 1 per cent fuel loss). Indirectly indicates proper draft conditions—thickness of fires, etc. Shows if boiler setting is leaky—indicates holes in fire. Shows proper timing of firing.

CO2 automatic gas recorder: Gives a continuous record of gas and excess air conditions in furnace. This instrument used to maintain furnace efficiency after working up with hand apparatus mentioned above. Indicates for the entire day the condition under which furnace has operated and gives a complete record of whether boilers were fired efficiently. Fireman can watch instrument to see if he is getting results, and in this way it is of great service. Some instruments have a bell alarm which rings if furnace is not properly fired.

Feed-water meter, weigher and recorder: Gives evaporation of water in boilers. In connection with coal-weighing device, gives evaporation per pound of coal and is index of comparative efficiency of evaporation. Also gives index of value of different coals. With no change in fuel, but drop in evaporation, it shows that some part of boiler plant needs attention.

Draft gage, simple and differential gage, boiler efficiency meter: Gives draft conditions in furnace, boiler passes, breeching and stack. Used to equalize draft in each boiler. Assists in showing furnace conditions. Adjustment of stack or uptake dampers and ashpit doors. Shows loss through passes and locates ash and soot accumulations in tube passages. Assists in locating air leaks in settings. Assists in determining proper firing conditions.

Thermometer, feed-water, indicating and recording: Shows temperature of feed water. If there is surplus of exhaust steam and water temperature is too low, indicates heater out of order, water inlet valve leaking or too much waste in overflow. (Each 13 degrees difference in feed water temperature due to exhaust steam equals 1 per cent. of coal.)

Steam flow meter, recording and indicating: Gives quantity of water evaporated or steam generated. Used in connection with coal weighing devices, it gives evaporation of water per pound of coal. Indicates if each boiler is pulling its proper load, if attached to each boiler. Indicates improper feeding of water to boilers. Indicates formation of scale in boiler by showing drop in efficiency. Assists in showing such things as holes in fires and shows up firing conditions. Recording meters will record the amount of steam going to any part of the plant or individual unit, such as pumps or engines, and thereby indicate condition of units. Can be used for recording steam sold for heating or other service. Of value in stopping losses caused by leaks between boiler and other points, also indicates internal leaks, such as blow-off line, if the input to boiler is known.

The Performance of Fuel Oil Engines in Water Works Service

By S. N. Connally, Fisher Bldg., Chicago, Ill.

It has been a very interesting study to watch the changes made in pumping equipment in the course of the last few years—in the pump itself and the various methods of driving. We, who are familiar with pumping equipment, have seen, in the larger plants, the slow-speed crank and flywheel Corliss pumps, and in plants of moderate and small capacity, the Myer and slide-valve crank and flywheel types, and the old direct acting simplex and duplex pumps. In the larger plants the Corliss and Reidler valve pumps, compound and triple expansion, have their place, but even in these the centrifugal pump is slowly but surely taking its place, and in the moderate and small-size plants it has practically supplanted the above types, owing to smaller space occupied, consequently smaller buildings and real estate, although at the sacrifice of power saving.

The steam turbine and electric motor, owing to speed conditions, are well adapted to drive centrifugal pumps, but the objection holds that turbines are heavy on steam consumption unless running condensing and in large units. Also, induction motors, slip-ring and squirrel-cage types, and even the highly efficient synchronous motors, are an expensive method of drive, except in the case of very cheap current from water-power sources.

Type of Pump and Method of Driving

Triplex pumps are not well adapted to turbine or motor drive except with belts, and modern power and pumping plant practice demands direct connection or gear drive of high efficiency. The water works engineer, in these days of high fuel cost, is confronted with two problems, i. e., the type of pump he will select and the method of driving. He may select the centrifugal pump for several reasons, but will still be undecided whether to drive it with turbine, electric motor or oil engine. His first thoughts probably are: "The oil engine is too expensive in first cost," and he has a doubt as to its reliability. The oil engine will be more expensive in first cost

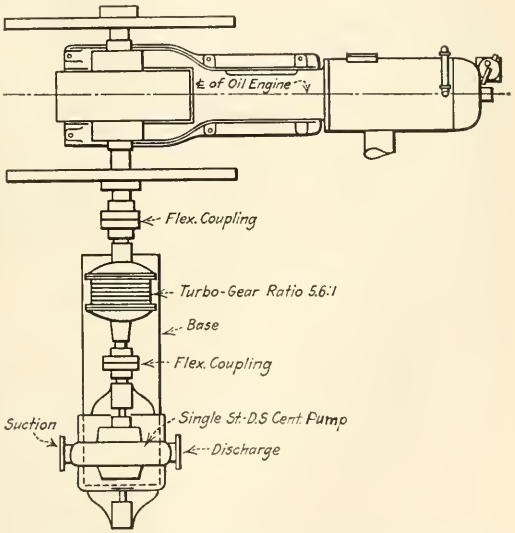


DIAGRAM OF INSTALLATION OF OIL ENGINE IN WATER PUMPING SERVICE WITH INTERNAL TYPE OF HERRINGBONE GEAR.

as compared with the electric motor, but not compared to steam pump or turbine, with its attendant boiler plant and large space required, because the oil engine is an entire power plant in itself.

As to reliability, there may have been a time when there was a question, but experience has made the modern oil engine a piece of apparatus which will meet the most exacting requirements.

We will not take into consideration in this article the true Diesel engine, owing to its extreme first cost, and the fact that it is built in only comparatively large units, but will consider the semi-Diesel oil engine of moderate compression,

which is moderate also in first cost and economical of fuel. There are several oil engines of this type on the market, both two and four-cycle, differing greatly in design and details. In general, the most dependable semi-Diesel oil engines on the market are those of the two-cycle type, simple in design and most accessible, and which employ crossheads instead of the trunk piston, have no valves, and the fewer moving parts the better. Both vertical and horizontal types are built, with the advantage in favor of the horizontal owing to ease of accessibility.

Assuming that the engineer has decided to use an oil engine to drive his centrifugal pump, he is naturally concerned as to the best method to use to adapt the speed of the oil engine to the pump. The best solution of this difficulty lies in the use of an internal type herringbone gear of high efficiency.

A New Oil Engine Pumping Unit

A line of water works pumping units has recently been placed on the market, which uses this type of gear increase between the oil engine and pump, as shown by the accompanying sketch.

This makes a very compact outfit, and is readily adapted to water works plants. The engineer is next interested as to the first cost of pumping plants.

Operating Costs

Without going into exhaustive engineering detail, it can be stated that the turbine pumping plant, with its turbines, pumps, boilers, piping, feed-water heaters, condensers, feed pumps, etc., will be high. The oil engine plant, with its oil engines, pumps, fuel tanks, circulating pumps, oil pumps, starting apparatus, next, and the electric plant, with its pumps, motors and starting equipment, low. Next he considers depreciation. Let us allow for this 5 per cent. per annum for the steam plant, 5 per cent. per annum for the electric and 10 per cent. for the oil engine driven equipment. Then we will consider the cost of attendance. The steam plant will require one engineer at $125 per month and one fireman at $75. The electric plant, attendance at $100 per month and the oil engine plant $100 per month. For cost of fuel, we will assume a concrete example, i. e., a pumping plant of 1,000 g.p.m. capacity against a total head of 200 ft. A centrifugal pump of this capacity, operating at 65 per cent. efficiency, will require about 77 b.h.p. The nearest commercial turbine is 80 h.p.; electric motor, 90 h.p.; oil engine, 80 h.p.

Cost of coal for steam turbine condensing, 10-hr. run; coal, $5.50 ton.....$16.50

Cost of current for electric motor, 10-hr. run; 3c per k.w. hr. 16.50

Cost of fuel for oil engine, 10-hr. run; fuel oil, 7c gal... 7.00

On a 300-day run, the saving on fuel cost by operating the oil engine would be $2,850.

Assuming, as above, that steam equipment life is 20 years, electric equipment life is 20 years, oil engine equipment life is 10 years, and taking the cost of an 80-h.p. fuel oil engine as $6,000, the saving in fuel alone would practically equal the first cost of the engine in two years.

Testing a Well Under Difficulties by Unusual Methods

By W. G. Kirchoffer, Sanitary and Hydraulic Engineer, Madison, Wis.

The city of Hartford, Wis., has an abandoned 10-in. well at the City Hall which they desired to use to increase the water supply for the city. The well was drilled many years ago, but was abandoned by the drillers before the contract was completed. The well was reported to be 893 ft. deep, but had never been tested for capacity. The records show that they drilled through 40 ft. of St. Peter sandstone. This amount of water-bearing rock, if of same capacity as the average sand rock in Wisconsin, should yield 80 gals. per minute with a lowering of 50 ft. The static water level was 25 ft. from top of casing.

Water Test

A preliminary test was made by filling the casing to overflowing from a fire hose near by and then noting the time required for the water to recede at each foot from the top. Table No. 1 is a record of this test.

TABLE I—RECORD OF PRELIMINARY WATER TEST
Size of casing, 10 ins.; capacity per foot, 4.08 gals.
Top of casing to water before filling, 25 ft.

Distance from top of casing to water, in feet.	Time required for water to recede to depth given in first column.
0	0
1	8 sec.
2	20 sec.
3	30 sec.
4	46 sec.
5	1 min. 5 sec.
6	1 min. 25 sec.
7	1 min. 48 sec.
8	2 min. 22 sec.
9	2 min. 35 sec.

The drop in the first few feet was accelerated, due to the velocity of the inflowing water from the hose attached to the discharge of an 8x10-in. triplex pump. The drop is fairly uniform after a depth of 4 ft. is reached. The test would indicate that if this method of testing a well was to be relied upon, the capacity should not be based upon the lowering in the first few feet.

This data would indicate that a supply of about 1 gal. per foot of lowering per minute could be obtained. Some of the city fathers doubted the correctness of the theory that a well will take as much water as it will yield under a given lowering and requested that a pumping test be made. No deep well pump nor power was at hand with which to make such a test, and it was useless to attempt a test by direct suction.

Air Test

At the power station of the city water and light plant there was an air compressor raising water from a 12-in. well. This compressor was a 6½x10x10-in., operating at 225 r.p.m., and delivering 203 cu. ft. of free air. It was suggested that air could be carried by means of 2½-in. fire hose from the compressor to the well, for the purpose of testing. This was done; the line was 800 ft. long, with 357 ft. of 1-in. air pipe in the well. An inserted casing for the discharge of the water should have been placed in the well, but as none was at hand, the well casing was used as a discharge pipe. A pressure gage was placed at each end of the line. Table II is a record of the test:

TABLE II—RECORD OF AIR TEST

Volume of free air (compressor displacement)	203 cu. ft.
Distance from compressor to well	800 ft.
Length of air pipe in well	357 ft.
Static lift	32 ft.
Static submergence	323½ ft.
Air pressure to start flow (both ends)	140 lbs.
Air pressure at compressor during flow	100 lbs.
Air pressure at well during flow	85 lbs.
Loss of pressure in 800 ft. of hose	15 lbs.
Time of discharge	35 sec.
Interval between discharges	3½ min.
Total period of discharge about	4 min.
In which time was delivered	200 gals.
Discharge per minute (about)	50 gals.

It required 140 lbs. to start the air lift. This was noted at both ends of the line. As soon as the water started, the pressure at the station dropped to 100 lbs. and 85 lbs. at the well, a loss of 15 lbs. at that initial pressure.

It is of interest to compare this loss with that given in table for friction loss in 2½-in. pipe when discharging 200 cu. ft. of air under 100 lbs. pressure. Bulletin 58L of the Sulli-

van Machinery Co., of Chicago, gives a table of such a loss, and for the conditions named it would be 1.12 lbs. for 100 lbs. pressure and 1.28 lbs. for 85 lbs. pressure. The volume of air at 100 lbs. is 25.62 cu. ft. and at 85 lbs. is 29.48 cu. ft. The same volumes of water discharged through 800 ft. of 2½-in. hose would show a loss of head of 82 lbs. and 98½ lbs., respectively. (Weston's tables.)

Owing to the small capacity of the well and the large discharge pipe, the flow was very intermittent, but, as given in table, about every 4 minutes 200 gals. would be discharged. The lowering of the water could not be measured, but from the drop in pressure it must have been 126 ft. during the 35 seconds of discharge.

This demonstration fully convinced the city fathers that the capacity of the well was too small to be considered as an effective aid to the city water supply.

FROM WORKERS IN FIELD AND OFFICE

Stone Spreader a Money Saver

To the Editor: Richland County, Ohio, owns two Burch (Burch Plow Works, Crestline, Ohio,) stone spreaders and their use has resulted in a substantial saving of labor and money. The data here given are based on our daily haul of 240 tons of crushed stone on I. C. H. No. 202 Sec. B, Mansfield-Galion road.

Before the spreader was used on this work we hauled with trucks, and this required five men on the dump at 35 cts. per hour, making an expense for an 8-hour day of $14 for spreading. Since placing the spreader in operation we have

BURCH STONE SPREADER IN OPERATION.

one man on the dump at 35 cts. per hour, making an expense for an 8-hour day of $2.80 for spreading. This means a saving of $11.20 per day on spreading, due to the use of the spreader.

The original cost of the spreader was $160, and as repairs, etc., are almost a minus quantity, the spreader pays for itself in less than 15 days.

Very truly yours,

BOYD WIERMAN,

Mansfield, Ohio, Aug. 13, 1918. County Surveyor.

Removing Silt from Irrigation Reservoir with Dragline Excavator

TO THE EDITOR: The greatest problem we have to meet in this country in the storage of water for irrigation purposes is the disposal of the silt which the water carries in suspension in flood times. Allowing this to accumulate in any reservoir would in a short time destroy the capacity of the reservoir.

We attempted to meet this problem a few years ago, by running all of the water intended for storage purposes through an auxiliary reservoir, which we called our settling basin, where the water was stilled and the silt settled out. This worked admirably for a period of years. But all too quickly this auxiliary reservoir became entirely filled with silt, supplying, therefore, no more settling capacity.

It was then, this spring, that we installed our Sauerman (Sauerman Brothers, Chicago) ½ cu. yd. levee type outfit, operated by a 50 HP Westman engine, and a Lidgewood hoist. With this outfit the silt has been handled in splendid shape.

We might add, that it is practically impossible to remove this silt with teams and any kind of scrapers. We attempted this one season after the settling basin had not been used for several months in the summer, and it was apparently well dried out. We found, however, that as soon as the top crust was removed, the silt was so wet and mucky underneath that it would not hold up a man, much less a team pulling a scraper.

The excavator under our conditions with a half yard bucket, handles very comfortably 125 to 150 yds. a day. We have operated such a brief time that we have not as yet complete cost figures, though we will be able to give these at the close of the season. In fuel consumption the engine is very economical.

Very truly yours,

THE GARMESA ORCHARDS CO.,

By Robert W. Lazear.

Fruita, Colo., Aug. 9, 1918.

REMOVING SILT FROM IRRIGATION RESERVOIR WITH SAUERMAN ½ YD., LEVER TYPE, DRAGLINE OUTFIT.
Bucket on Cable at Beginning of Work. Bucket Dumping at Base of Mast Back of Reservoir Dam. Appearance of Pit After Two Months of Work, Approximately 200x75 ft. by 20 ft. Deep.

Sprinkling Filter System and Auxiliaries vs. the Activated Sludge Process

To the Editor: Mr. T. Chalkley Hatton has done well to emphasize the protection that should be afforded riparian owners and others liable to annoyance or damage from the presence of sewage disposal plants or their effluents, irrespective of economical consideration. Consideration is due to their point of view as a matter of justice, and it is to be hoped that this broader and more human aspect of the question will be more generally held in the future than heretofore. *The general welfare and happiness of the community* should be the end sought, not the mere saving of dollars and cents by the transgressor.

It is perhaps a little early to pass judgment on the relative merits of trickling filter and activated sludge plants, but this is a matter that sanitary engineers are eager to have cleared up and Mr. Hatton's article marks an important step in this direction. Most of his claims for activated sludge will hardly be questioned, but there will probably be a difference of opinion as to the last three advantages mentioned: Disposal of Sludge, Cost of Plant, and Cost of Operation.

The activated sludge process is somewhat elaborate, and if the large volume of sludge is not promptly dewatered there is the grave possibility of odor. This, of course, may occur with any kind of treatment, but with a greater resulting nuisance with activated sludge than with a somewhat inferior Imhoff sludge. Moreover, the relatively small volume and lack of offensive odor in well-digested sludge will permit its transportation and exposure on drying beds.

The operation of dewatering activated sludge appears to be in the way of successful solution either by presses or centrifugals and heat drivers, but the writer is "from Missouri" and awaits more complete information than is now available from the few briefly-operated plants now in existence, before forming a general opinion.

And the same may be said as regards cost. This will necessarily vary materially with the character of the sewage, the local labor market and the price of fuel and power. In New York City, for instance, power would cost about twice as much as at Houston, which places the matter on quite a different footing. It would appear that in some of these respects the city of Houston may have had the advantage of Fitchburg and Gloversville. And changing war conditions may also alter existing relations materially.

The relative economy of the activated sludge as compared with other processes depends very largely on the sale of fertilizer. Activated sludge has been shown to have a very considerable value in this respect, as stated by Mr. Hatton, and even if only the cost of dewatering is covered in this way it is a great point gained, as this seems to be an essential concomitant to successful operation.

Personally, the writer believes a comparison of cost between the two methods is liable to be misleading without pretty full knowledge of, and allowance for, local conditions, and this will in the main account for the apparent discrepancy between the figures of Mr. Eddy and those of Mr. Hatton.

As far as the public is concerned, the activated sludge process has not yet emerged from the experimental stage—in particular regarding tank design, aeration and dewatering—and possesses little definite data from operative plants if we omit those furnished by the admirable installation at Milwaukee. Under favorable conditions, however, the writer believes that the activated sludge process has a useful future and that to Mr. Hatton and his chemist, Mr. Copeland, credit should be given for its successful development in this country.

Very truly yours,

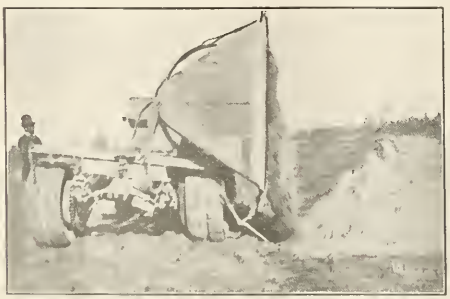
KENNETH ALLEN, Sanitary Engineer.

Board of Estimate and Apportionment,
New York City, N. Y.

PLANT UNITS AND LAY OUTS

A Side Dump Body for Motor Trucks and Trailers

Reduced delivery cost on all bulk materials is secured by the use of the Winsor gravity side dump body here illustrated. If a trailer is used the truck load can be discharged without



WINSOR GRAVITY 6-YARD DUMP BODY ON 5-TON TRUCK DUMPING 5 YDS. OF GRAVEL.

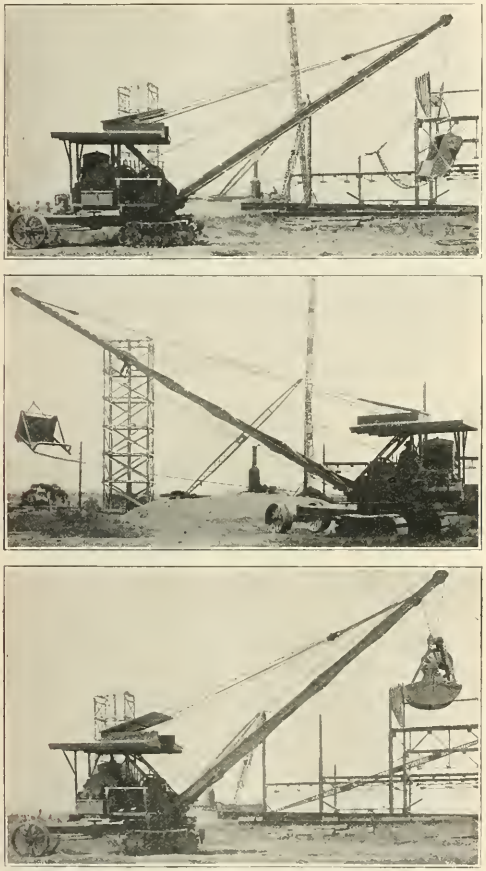
disconnecting the truck from its trailer. The load can be discharged to either side and clear of the wheels. No power is required to operate the dump body and it has no mechanical parts to get out of repair. After discharging by gravity the body returns to an upright position by gravity and automatically locks. The bodies are quickly removed, making way for loads of lumber, structural steel, etc. The Department of Public Works of Detroit has, in its asphalt repairs section, a Dodge roadster equipped with a Winsor 1 cu. yd. gravity dump body that is insulated with asbestos. On the statement of A. C. Proctor, asphalt expert of the department, this outfit performs the work of three teams at an expense of $7.50 per 10-hour day. The bodies are made by the Winsor Gravity Dump Body Co., Inc., Detroit, Mich.

A Portable Corduroy Traction Drag-Line Excavator for General Use

A portable corduroy traction drag-line excavator, weighing but 13 tons, for backfilling, for general drag-line work and for handling material with a ½-cu.yd. clam-shell bucket, has been perfected by the Pawling & Harnischfeger Co., of Milwaukee. The machine is here illustrated. For backfilling it can be used with a 30, 40 or 50-ft. boom and the P. & H. ½-yd. self-acting scraper bucket. It is suitable for digging irrigation and drainage ditches. This machine is also used to advantage as a portable locomotive crane. When equipped with a clam-shell it is used for loading or unloading screenings,

crushed rock, sand and gravel, or any other work requiring the use of a clam-shell bucket. With this machine the contractor can also unload heavy sections of cast iron, vitrified clay and concrete pipe from cars to trucks and from trucks to trench. The machine will also pull sheet piling. The machine is built of the highest grade material throughout. The gears are made of either steel castings or steel forgings, and all the high-speed spur-gears have teeth cut from the solid.

The under-frame is built up of structural material and is supported at one end by a pair of corduroy tractions, each 18 ins. wide and 4 ft. 9¾ ins. long from center to center of end sprocket shafts, and at the other end by a pair of traction



VIEWS OF NEW PAWLING & HARNISCHFEGER PORTABLE CORDUROY TRACTION DRAG-LINE EXCAVATOR, AS EQUIPPED FOR DRAG-LINE, BACK-FILLING AND CLAM-SHELL WORK.

wheels 38 ins. diameter by 16 ins. face, mounted on an axle which is pivoted for steering.

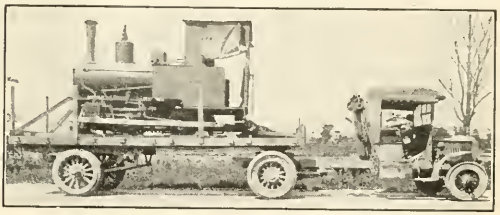
The corduroy grip tractions are driven by means of gearing from a propelling shaft extending across the under side of the under frame. Seven-inch ship channels, 18 ins. long, securely riveted to the link castings, form the tread of the corduroy. Self-adjusting rollers are provided between the end sprockets for transferring the weight of the machine to the ground. The general design of these tractions is such that they can easily be dismantled for repairs.

The revolving frame consists of a heavy semi-steel center casting with structural steel side and cross-members, reinforced to stand swinging strains. The machinery is driven by a four-cylinder, 30-h.p. vertical motor of the internal combustion type. The revolving frame is rotated by means of a train of gears between the jackshaft and the swinging gear bolted to the top of the under frame. A 12-in. diameter drum driven from the digging shaft is provided for hoisting and lowering the boom. Operating levers and brakes are concentrated at the right side of the machine, giving the operator a full view of the work, and making one-man operation possible.

The machine appeals strongly to the contractor because of its universal application and its economical operation.

Semi-Trailer Solves Transportation Problem for Road Commissioners

The difficulties encountered by the road commissioners of Wayne county, Michigan, in securing freight cars for the transportation of material and equipment to the different parts of the county where road building work is going on, forced them to adopt a truck and trailer unit which is giving satisfactory service. From their base at Wayne they are compelled to haul supplies and equipment to the most remote sections of



HAULING 10-TON INDUSTRIAL LOCOMOTIVE ON 10-TON FRUEHAUF SEMI-TRAILER WITH 4-TON TRUCK, WAYNE COUNTY, MICHIGAN.

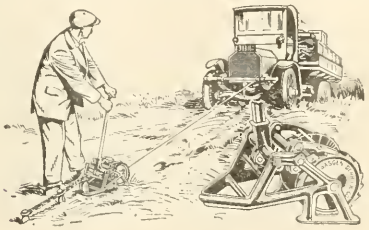
the country and are often rushed to keep supplied the several crews of road workers. The varied nature of these supplies and the long hauls presented a problem that is complex.

By using a 10-ton Fruehauf semi-trailer in connection with a 4-ton truck, they were able to cope with the situation and place themselves in a position to be independent of all other methods of transportation.

Hauling an industrial locomotive by motor truck seems a little bit out of the ordinary, but it is a possibility nevertheless. The 10-ton locomotive is one of several used about the county.

A Truck, Car and Stump Puller

The Sasgen truck car and stump puller, illustrated herewith, is built of crucible steel. The handle has a compound motion. The drum can be released in an instant by raising the lower dogs against the upper and pushing the lever back. The puller is anchored by three steel stakes which are connected to one another by a chain. For pulling cars the puller



THE SASGEN TRUCK CAR AND STUMP PULLER.

is hitched with a chain to a rail. The puller is strong enough to pull small stumps. It is also handy to place on a truck body to pull heavy loads onto the truck. It is manufactured by the Sasgen Derrick Co., of Chicago.

A Drag-Line and Clam-Shell Bucket Machine with Attachments

The Austin drag-line with 18-ft. combination boom, 11-ft. "bite" and ½-yd. skimmer scoop, and guided draw dipper for shallow work, road and park improvement work, grading and trench work, is here illustrated. This boom equipment is an attachment to the Austin drag-line with multi-pedal traction. A boom suitable for adjustable dipper of the standard shovel type can also be secured. For long-range backfilling a special 50-ft. boom can be used.

The standard boom with this drag-line and clam-shell buck-

AUSTIN DRAG-LINE AND CLAM-SHELL BUCKET MACHINE, EQUIPPED WITH SKIMMER SCOOP ATTACHMENT.

et machine is 30 ft. long. This excavator is constructed of three units: the lower frame or sub-structure, the upper frame or superstructure, and the boom and bucket. These parts, as assembled, form a complete operating machine for excavating earth, trench digging, street grading and wagon loading, railroad ditching, handling coal, sand, gravel, crushed stone or other similar materials. For operating or transporting purposes the excavator is mounted on multi-pedal traction, capable of moving forward or backward or turning at any angle in either direction. The power plant consists of a vertical type, heavy duty engine, operated by either gasoline, kerosene or distillate. The machine is manufactured by the F. C. Austin Co., Inc., Chicago, and is fully described in Bulletin No. 106.

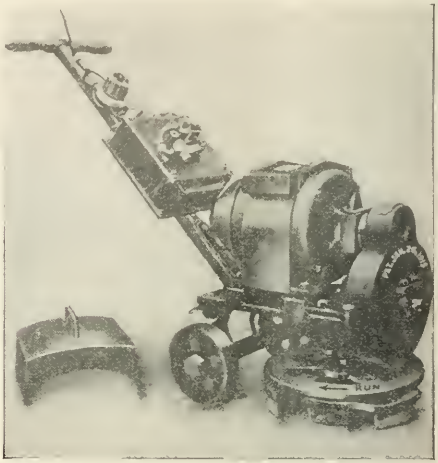
Blasters' Handbook

A pocket text book called the Blasters' Handbook, has just been issued by E. I. du Pont de Nemours & Company, of Wilmington, Del., which tells in detail how to blow soot from big chimneys, how to break up old boilers and heavy machinery, and how to use explosives for every purpose where their employment is practicable. This book gives valuable information regarding the proper explosive to use, the quantity, the method of loading and firing. It is well illustrated and contains charts and diagrams that make this work a valuable addition to any technical library.

A Motor-Operated Surfacing Machine

To meet the demands for a surfacing machine suitable for small jobs and the repair and maintenance of tile, marble, granolithic and composition floors, the Cavicchi Polishing Machinery Company, of Quincy, Mass., has developed a one-man type operated by an electric motor.

It can finish flush with the walls and owing to the construction of the surfacing wheel can be used on irregular surfaces. This wheel is composed of concentric segments which revolve independently of each other, to which the grinding blocks are



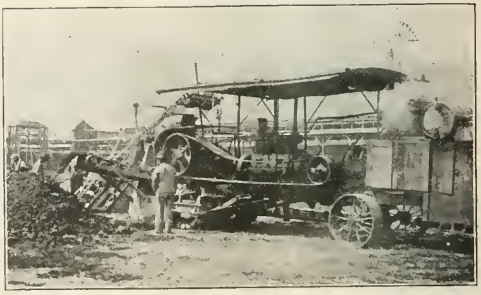
SURFACING MACHINE FOR REPAIR AND MAINTENANCE OF FLOORS.

attached. These blocks are 2⅛ in. high and wear to ⅜ in., when they can be easily replaced.

Practically the entire weight of the machine is located directly over the grinding surfaces. Operation and speed control are regulated by the switch and rheostat located on the handle of the machine. The surfacing wheels are actuated by a fractional (¾) horse power motor, made by the General Electric Company for the prevailing current which can be taken from a convenient socket.

Austin Trenching Machine on Rush Job

An unusual rush sewer job was occasioned by the necessity of providing temporary sanitary facilities for the U. S. Government War Exposition, which opened in Grant Park,



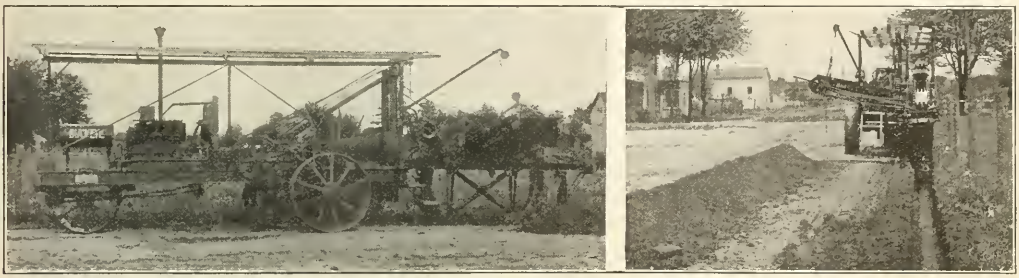
AUSTIN MACHINE EXCAVATING SEWER TRENCH FOR CHICAGO WAR EXPOSITION.

Chicago, September 2. The contract, which was turned over by the South Park Commissioners to the Chicago Drainage Construction Company, called for the laying of approximately 3,600 ft. of 8-in. pipe. The digging was particularly difficult,

as Grant Park is mostly made land, full of boulders and other obstructions. The use of an Austin trenching machine enabled the contractor to handle the work within the short time-limit allowed, in spite of the different excavating conditions. The best day's record was 400 ft. of pipe laid.

A Curb Line Excavator

The curb digger here illustrated is manufactured by the Buckeye Traction Ditcher Co., Findlay, Ohio, and is built along the same general lines as the trench excavator manufactured by the same company, with the exception that the wheel is offset to one side. This construction makes possible the machine digging of curb trenches from 12 to 36 ins. wide and from 3 to 4 ft. deep, depending on the size of the machine. The No. 1 will dig 12 or 18 ins. wide by 3 ft. deep; No. 4, 18 or 24 ins. wide by 4 ft. deep, and the No. 4-A, 24 or 36 ins. wide by 4 ft. deep. It has a cutting speed of from 2 to 8 ft. per minute for the small machines and from 3 to 12 ft. per minute for the large machines. The equipment is driven by a 4-cylinder, heavy-duty, slow-speed motor. It has a road speed of 1¼ miles per hour. On contracts of any size road and street paving contractors will find this machine a money-saver.



SIDE AND END VIEWS OF BUCKEYE CURB TRENCH EXCAVATOR.

Successful Application of Tractor on Heavy Road Grading

Recently the county highway commissioners at Grand Forks, North Dakota, conducted a demonstration of the capabilities of tractors on road work. The Lanson tractor participated in this demonstration and performed, it is claimed, to the satisfaction of the commissioners. This tractor, at the demonstration, pulled a giant road grader, cutting a berm in virgin sod on a crown of 6% without any side draft. This performance was continued for eight hours without heating the water in the radiator.

The tractor, equipped with a fly-wheel, is adapted also for driving a stone-crusher and other types of machinery used on road construction. The tractor is equipped with a patented gear set locking device which prevents a careless operator stripping the gears. It is made by the John Lauson Manufacturing Co., New Holstein, Wis.

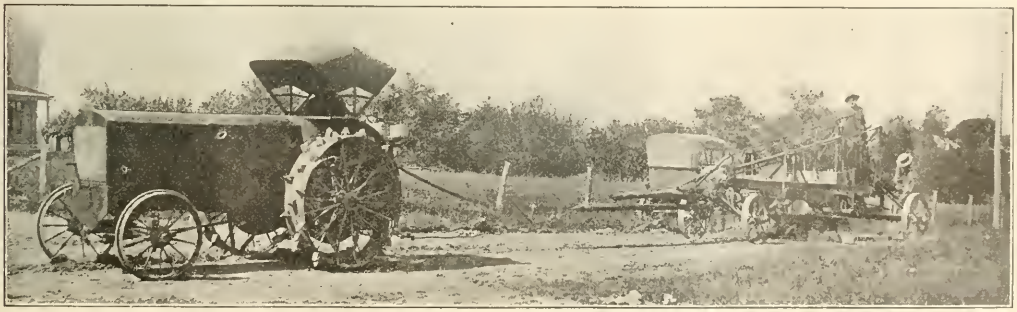
The Jarmin Gravel Loader

The Jarmin gravel loader is essentially a portable machine, and was especially designed to handle sand, gravel or other similar material at a minimum of expense. Many of these loaders are in use throughout the Northwest, especially by counties and contractors. Some of the counties have several of these loaders for use in different sections where gravel for road work is available. The loader is manufactured by the Spokane Culvert and Tank Company, Spokane, Wash.

The economy effected by using these machines is considerable, some of the costs being as low as 7c per yard. In no instance has the cost exceeded 10c per yard when sufficient material is delivered to the machine. One man only is required to operate the loader itself, and one or more men to deliver material to it by means of fresno, drag-line scraper or other equipment, according to local conditions. Usually one man with team and fresno is sufficient to load as much gravel as the teams will be able to distribute on the road.

The elevator and engine are mounted on a steel channel frame. The elevator can be lowered easily when it is desired to move the machine. The engine is either 6 or 8-h.p., to suit the work to be done. Sometimes a revolving screen is used in connection with the loader and is operated by it.

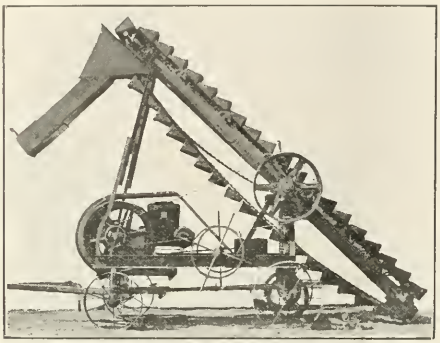
This loader is made in two types. One of these types is with digger buckets equipped with cutting edges of high carbon steel, to take the wear in scooping up loose gravel, sand or other loose material from the ground level, the machine being moved forward as necessary to a new supply of material by means of a hand moving device. These extra lips or edges are, of course, renewable as may be necessary, though they



LAUSON TRACTOR PULLING ROAD GRADER AT GRAND FORKS, N. D., TRACTOR DEMONSTRATION.

will last a long time in ordinary service. With this type the gravel is loaded directly into wagons or trucks.

The other type is made to load from below the ground level. In this case a hopper is installed at the lower end of the elevator, the top of the hopper coming even with the surface of the ground. Over this hopper a platform is built of plank, with a hole cut through the same size as the opening



VIEW OF JARMIN GRAVEL LOADER.

in the hopper, thus permitting driving across the platform and dumping into the hopper through this hole. In using this type the material may be loaded either into bunkers or directly into wagons or trucks, and the loaders may be moved to a new location from time to time, as may be necessary, according to the supply of material available.

The machine, it is claimed, will load from 30 to 50 or 60 yds. per hour, if sufficient material is brought to it.

Personal Items

C. E. Drayer, of Cleveland, Ohio, has been engaged by the Board of Directors of the American Association of Engineers to serve as national secretary. Mr. Drayer has been actively engaged in engineering society work of a local and national character for the past eight years. After graduating from college in Cleveland, Ohio, he served on western railroads until 1910, when he returned to Cleveland to become field engineer for the Nickel Plate Railroad on grade elimination work. He immediately joined the Cleveland Engineering Society and, as opportunity offered, took measures to advance the engineer in public esteem and to encourage him to train himself to be a leader in service to the community. After two years of marked success in the local society in Cleveland, he began to carry the message of progress to other societies and in time addressed most of the engineering organizations east of the Mississippi. In 1915 he became associated with Dr. F. H. Newell in forming the Committee on Engineering Cooperation of which he is secretary. He organized and is secretary of the Ohio Association of Technical Societies. He is co-editor of "Engineering as a Career," a series of articles of advice to young men. For several years he was editorial correspondent for "Engineering News" and "Engineering News Record," where most of his articles on engineering society organizations have appeared. He served the Cleveland Engineering society as its secretary for two years, and was a member of its executive board when elected secretary of the American Association of Engineers. He formulated the plan of combining the membership of the American Association of Engineers and Cleveland Engineering Society which promises to have a profound influence on engineering organization.

Bertram Brewer, formerly City Engineer, Superintendent of Water Works and Sewers at Waltham, Mass., is now with the engineering department of the Massachusetts Department of Health with headquarters in Boston.

Chester G. Wigley has resigned as Chief of the Bureau of Engineering of the New Jersey State Department of Health, to become associated with the engineering staff of Wallace & Tiernan Co., Inc., manufacturers of Chlorine Control Apparatus and Sanitary Engineering Specialties, with headquarters at 137 Centre Street, New York, N. Y.

John W. Toyne, engineer, 457 Farmers Trust Bldg., South Bend, Ind., has been commissioned a captain in the Quartermaster's Corps, U. S. Army, and assigned to Camp Custer, Battle Creek, Mich. For several years Mr. Toyne was superintendent of water works at South Bend.

H. M. Freeburn has resigned as assistant engineer of the Pennsylvania State Department of Health, to become associated with the engineering staff of Wallace & Tiernan Company, Inc., manufacturers of chlorine control apparatus and sanitary engineering specialties. Following his graduation from the sanitary engineering course of the Pennsylvania State College, Mr. Freeburn was an instructor at the institution and was in charge of experimental sewage work. Subsequent to this he was associated with the engineering branch of the Pennsylvania State Health Department.

Prescott G. Brown, captain of engineers, National Army, announces that the consulting engineering business of Mason L. Brown & Son, will be conducted under the same name by Prescott G. Brown as the successor. Mason L. Brown died on July 6, 1918. The business will be carried on the same as before with the same staff of engineers and assistants, and the office mentioned as heretofore at 819-824 Chamber of Commerce Bldg., Detroit, Mich.

Ossian E. Carr, of Niagara Falls, N. Y., has accepted the position of city manager of Springfield, Ohio, at an annual salary of $6,000.

Charles Brossmann, consulting engineer, Merchants Bank Bldg., Indianapolis, and Frank C. Wagner, profcssor of Mechanical engineering, Rcse Polytechnic Institute, Terre Haute, Ind., have been appointed by the United States Fuel Admistration to take charge of special fuel conservation activities in Indiana industries. Mr. Brossmann's duties will be limited to investigation of electric power plants in the state for the purpose of making recommendations for the consolidation of certain plants in order to save fuel. The plants that will come under his observation will be public service electric plants, electric railway power substations and small power plants in other industries. Where it is found that current can be obtained from another source with a saving of fuel, recommendation will be made for closing the plant or consolidating it with another. For many years Mr. Brossman has been identified with large engineering projects. For ten years he has been secretary of the Indiana Engineering Society.

George M. Zimmerman, who tendered his resignation as city manager of Sandusky, Ohio, effective August 1, reconsidered and decided to remain when the city commission increased his salary from $3,600 to $5,000 a year.

Catalog Review

Housing—"Permanent Homes Make Permanent Workers," issued by Truscon Steel Co., Youngstown, Ohio. 8½x11 ins.; 16 pages. An exposition of the advantages of stucco on metal lath construction for industrial housing. The pamphlet is well illustrated and gives ample descriptive matter and detail. The particular advantages of Hy-Rib Metal Lath are clearly shown.

EDITORIALS

Will Illinois Prepare For Peace?

Thoughtful people, the nation over, are awaiting with keen interest the vote at the general election in November when the people of Illinois will decide for or against the issuance of $60,000,000 of bonds to pay for a state-wide system of durable, hard-surfaced roadways upon the public highways of the state, comprising 46 intercity routes. This bond issue provides a test of the intelligence of the people of the state and it is, therefore, of national significance. If the issue is approved it will indicate that the voters are capable of looking into the near future; if it fails it will demonstrate conclusively that they cannot see past the ends of their nasal organs. The vote will test the ability and willingness of the people to prepare for the return of peace. The proposition has the endorsement of the governor as distinctly a preparation-for-peace measure. Until the close of the war bonds will not be sold and construction will not begin. When peace does come, as it must come, the great construction program will be ready to launch if the people vote "yes" now.

Incidentally, this bond election provides an opportunity for the average citizen to secure something for nothing, which was ever the dearest wish of the well known human heart. No one will dispute that the comprehensive system of highways contemplated will be beneficial to every citizen of the state and these good roads are to be had by the average citizen without the expenditure of so much as one cent. The average citizen does not own an automobile and these roads are to be paid for exclusively with money received in the form of state automobile license fees; both principal and interest on the bonds will be paid in this way. Taxes will not be increased. The automobile owners are not only willing, but are anxious to stand the expense.

Over $30,000,000 of the $60,000,000 will go to laborers. This points the way to adequate preparation in Illinois for the return of peace. Illinois believes in preparedness for war; does she believe in preparedness for peace? The people must decide at the polls.

"Nothing Else Counts"

Across the letterhead of a correspondent this slogan is printed: "Our Business is to Win the War—Nothing Else Counts."

Slogans must be brief to be effective, and it would be unfair to read into them a meaning they neither express nor imply, but the slogan here quoted is at least half bad. That the first and most important business of this country is to win the war will not be disputed by any patriot, but the idea that nothing else counts is merely the present day manifestation of the national tendency to ignore the future. Some say the greatest danger now confronting this country is a feeling of overconfidence about the early and favorable termination of the war, but it seems an even greater danger lies in the tacit assumption that we need only win the war and everything else will take care of itself thereafter and be perfectly lovely for evermore.

When the soldiers and sailors return to their homes at the end of the war and have received our homage they are going to ask what we have been doing while they were away. Let us think now of the answer we shall make. It is the function of the soldier to end the war but it is our function to prepare for the peace that shall follow. It is said the soldiers are wondering how their efforts are regarded by the folks back home. This does credit to their modesty but it should not mislead us. What we think of them is best expressed by the sacrifices we now make to support them and by the plans we now make for the period immediately following the war. Rooting from the side-lines is natural and easy; saving food is a bit difficult to the individual but undoubtedly benefits his health; buying bonds leaves a pleasant patriotic glow, but is essentially the best investment in the world—we must do more than these things. We must do a very difficult thing; we must plan for the future. In this land of chronic unpreparedness that is indeed difficult.

In the municipal and county field it should be easy to prepare for peace. The needful thing is to have plans ready so that as soon as our own government takes down the bars, construction work can begin. It would seem that city officials would be planning improvements now for construction after the war. Are they? Some are, many are not. In these columns two months ago we published an editorial entitled, "How Are the Plans Progressing?" It was urged that cities utilize the present lull by planning future improvements. Judging by the number of requests we have had for reprints of that editorial, many cities are taking absolutely no thought of the future.

City officials should have a care that the day of glory on which the soldiers return is not followed by a day of wrath when the soldiers learn that nothing more substantial than a flimsy reviewing stand has been planned in anticipation of their return.

Unwisdom of Restricting Road Construction Well Illustrated in Pennsylvania

When conditions in Pennsylvania are considered the opposition to road construction almost reaches the proportions of hostility. Never was the need for good roads more clearly indicated than in that wealthy and populous state, yet we find applied there the same restrictions imposed in states of relatively small wealth and sparse population.

Unless the United States Highway Council recedes from the stand first taken, road construction in Pennsylvania will practically cease until after the war. There are 64 roads now under construction. The Council has disapproved, or taken no final action, on all except 9 of these roads. This means that work on these roads must cease as materials cannot be ob-

tained for roads disapproved by the Council. That these are important roads may fairly be inferred from the fact that local authorities are paying one-half the cost of the improvements.

In a press release, issued by the State Highway Department, the statement is made that the department is of the opinion that the U. S. Highways Council has failed to realize the importance of road work in Pennsylvania and the great hardship that will be imposed upon the local communities by leaving the roads in an unfinished condition. While nothing may come from their courageous devotion to duty, the State Highway Department is entitled to all praise for making a defense of the cause of improved roads during the present emergency. Just how important these roads are may be gathered from the following quotation from the release mentioned:

> No one can question the willingness of Pennsylvania to co-operate with the Washington authorities. Pennsylvania is doing her full share, and will continue to do so, but good roads are not only essential and necessary as a war measure, but they are a vital economic necessity, particularly in a great industrial, manufacturing and mining state like Pennsylvania. This was demonstrated last winter when many of the large industries of the state were seriously handicapped, only being able to operate by reason of their ability to transport their coal from the mines, and various other supplies, over the highways of our state, in trucks. Manufacturers and other wholesale dealers in Pittsburgh, Philadelphia and other large centers now deliver their merchandise by trucks over the highways within a radius of 40 and 50 miles. A great majority of all the army trucks pass through Pennsylvania.

Last winter a continuous stream of army trucks, loaded with munitions and supplies passed through Pennsylvania to the seaboard. These trucks and supplies are now being used on the battlefields of France. Nearly $2,500,000 has been spent by the State Highway Department during the past six months in rebuilding and repairing roads used by army trucks and by manufacturers engaged in war work. If roads like these are not essential in war times, the U. S. Highways Council might just as well say, first as last, that there isn't any such thing as an essential road. This cannot be done, however, without flatly and categorically repudiating their policy as recently promulgated.

It is hoped, at the time of writing, that the Council will modify its Pennsylvania rulings to the extent at least of approving the projects now under construction for which a large percentage of the requisite material is actually on the ground.

It is not conceivable that any section of the business community would regard these roads as anything but essential in the highest degree. The fallacy that funds are lacking for road work has been exploded. Moreover, the Pennsylvania State Highway Department has made a study of the labor situation and is ready to present evidence that the greater percentage of the men on road construction are men unfit for army service or for work in munition factories.

In the light of these circumstances the statement of the Council that it hopes "to render active aid on the projects it approves" leaves one in doubt as to whether this statement is a threat or a promise.

The War and Money

When the war started, August, 1914, economists ridiculed the opinion advanced by military men that it might last for years. The economists were able to prove to their own satisfaction that the war could not last longer than six months for by that time the belligerent powers would all be bankrupt. Since then economists, financiers and bankers have learned something about money.

The American Bankers' Association recently held their annual convention. In his address Charles A. Hinsch, Cincinnati, O., president of the association, said that this country can raise $300,000,000,000 for the purpose of winning the war, if need be, and by the time that is used up can raise a few more billions for the same purpose. He said there is literally no limit to the amount of money that the United States can raise. Coming from a banker, these statements admit of no discount.

Last month it was pointed out here that the lack of money is not the thing that is stopping highway improvement work. Bankers admit that money for road improvements would be forthcoming if roads were pronounced essential. Let it be clearly understood there is no lack of money, present or prospective.

Influence of Engineers on Selection of Construction Equipment

A few years ago the publishers of engineering papers discovered the contractor. Since then some of their representatives have almost lost sight of the engineer. Feeling that the contractor is the man who buys the equipment which is advertised, and thus makes possible the existence of engineering papers, many of the solicitors have felt that the contractor is all-important as a subscriber.

Without for a moment disputing the soundness of some aspects of this opinion, it should at the same time be evident to every one that the engineer also exerts a tremendous influence on the selection of construction machinery and supplies. This influence takes different directions. In some cases where the construction is carried on by force account, the engineer has the entire say-so about the selection of the equipment. With reference to the materials, of course, the engineer's specifications usually determine directly or indirectly the choice of the materials. But it is to another aspect of the matter, so frequently overlooked, that special attention is called.

Whatever contractors may say about engineers and their grade stakes, their blueprints, their specifications, etc., the contractor has a wholesome and abiding respect for the engineer and frequently asks his advice when contemplating the purchase of construction machinery. This advice is not always asked for in so many words. It sometimes happens that the contractor attempts to solicit this information without asking for it directly, but he wants it just the same, and the obliging engineer gives it. It would be interesting to know just how many pieces of important construction machinery have been bought and paid for by contractors on the direct or indirect recommendation of the engineer. We feel that the percentage of equipment so selected is very high. Manufacturers, therefore, can make no greater mistake than to assume that the engineer subscriber is not quite as important as the contractor subscriber from the advertiser's standpoint.

Pavement Design and Construction

Special Underdrainage Safeguards New Cleveland Pavement

By Fred R. Williams, Engineer of Paving, Cleveland, Ohio

Woodhill Road and East 93rd street in Cleveland, Ohio, is the most important cross-town thoroughfare in the southeast section of the city. In consequence it carries an immensely heavy traffic; passenger vehicles and commercial trucks make a steady stream in addition to street railway cars, which use a double track and operate on 3-minute headway.

Old Pavement Replaced

The street has been paved for several years, for the most part with vitrified brick laid on a sand cushion and 4-in. concrete base. The condition of this pavement made it necessary to replace it; the concrete in the old base was of poor quality; the sand cushion specified to be 2-in. deep was 4 ins. in many places; so great a depth of cushion could not be thoroughly compacted so that joints between the brick were filled with sand to the exclusion of the grout filler.

The subsoil is of heavy clay. For a considerable distance Woodhill Road lies along the edge of a cliff, and this location, combined with the impervious subsoil which made drainage difficult, contributed to the need of renewal.

The New Pavement

A new brick pavement is being built this season. The weight and volume of traffic made a substantial pavement imperative. The street is therefore being repaved with brick of two types; one section of 5-in. brick laid upon 7 ins. of green concrete, the other, 5-in. brick laid upon a 1-in. cement-sand bed and 6 ins. of concrete. In both sections there is, therefore, a solid pavement 12 ins. deep which we expect to be adequate for both present and future traffic.

Special Underdrainage

Special underdrainage has been provided to safeguard the new pavement, as distinguished from the standard underdrainage requirements of the city of Cleveland, on the grounds that while the standard type is adequate for the majority of pavements in the city, any unusual requirements make amplification necessary.

For the past 2½ years no pavement has been built in Cleveland that did not have a line of 4-in. vitrified clay pipe of the ball and socket type 6 ins. below and outside the curb on either side of the street. In fact, on the west or down-hill side of Woodhill Road, the standard type of underdrainage was retained.

On the up-hill side, however, the size of curb pipe was increased to 6 ins., and 4-in. laterals laid 45 degrees to the curb were added every 50 ft.

The total width between curbs is 44 ft.; the double car tracks require 15 ft. in the center of the street so that the pavement on either side is 14½ ft. wide. Laterals were brought to within a few inches of the ends of the ties; at this point the tops of the laterals were 6 ins. below the base of the pavement. A fall of about 8 ins. was provided to quicken the discharge into the main 6-in. line back of the curb, which in turn discharged into 12-in. catch-basin connections.

VIEWS SHOWING SPECIAL UNDERDRAINAGE OF NEW BRICK PAVEMENT ON WOODHILL ROAD IN CLEVELAND, OHIO.

On Down-hill Side a 4-in. Vitrified Clay Pipe is Placed 6 Inches Below and Outside Curb. On Up-hill Side this Curb Pipe is 6-in. and Has 4-in. Laterals at 50-ft. Intervals Laid 45 Degrees with Curb.

Lateral trenches were backfilled with well-rammed cinders up to the base of the pavement; cinders also support the curb on either side, as well as covering the 6-in. main line with at least 12 ins.

At intersections, the end of the lateral next to the ties was buried deeper and a supplementary lateral was laid at right angles to discharge into the end of the diagonal lateral. The purpose is, of course, to clear water from all parts of the intersection, and it was found to be a feasible method.

War conditions made it impossible to secure burlap to cover the pipe joints; in the place of burlap, a thin layer of straw was laid over the pipe, and as far as can be determined, is quite satisfactory.

The Asphalt Roads of Cook County, Illinois

By Walter H. Flood, Chemical Engineer and Consulting Chemist, 22 Quincy St., Chicago, Ill.

Cook County has paved, with the money from its bond issue, five main roads with asphaltic concrete: Higgins and Rand Roads, Archer Avenue, 95th Street and 147th Street. Higgins Road extends from the city limits to Dundee, a stretch of over 25 miles. All of this is not completed but a large portion has been open to traffic for some time and the remainder is under construction. It will receive heavier traffic than any of the other roads as it is the only direct connecting link between the city and the large truck farming district through which it runs.

Change from Macadam to Concrete Base

The first specifications for the asphalt roads constructed under the bond issue called for a 2-in. wearing surface on a macadam base and a portion of the paving was laid this way. Some of this has been down two years and shows up well with the exception of a few places which have become a little uneven due to settling of the base. It was afterward decided to put down future pavements with a concrete base, as the cost is but little higher than for macadam base and the results are more satisfactory.

Trinidad Asphalt Used

All types of asphalt are admitted under the specifications, but thus far only Trinidad has been used on the roads. The specifications for the asphalt cement or bituminous binder are essentially those of the Illinois State Highway Department and are classified into three groups to include oil, blown oil, and natural asphalts. There are no specifications for refined asphalt or flux. The following are the specifications covering Trinidad asphalt cement:

Specifications for Trinidad Asphalt Cement

The asphaltic binder shall be produced by the refinement or distillation of crude native bitumen of an asphaltic nature and the combination therewith of a fluxing oil, when the nature of the bitumen requires it, to produce the proper consistency for use in the pavement. The asphaltic cement may be delivered from the refinery at the proper consistency for use without the further addition of flux, or the refined solid asphalt may be delivered to the paving plant and there combined with the necessary amount of flux. The flux may be a paraffine, a semi-asphaltic or an asphaltic residuum suitable for the particular grade of asphalt used. The asphaltic cement proposed for use in the pavement must possess the properties hereinafter described and which has demonstrated that it retains these properties by having been in successful use in asphaltic concrete pavements.

Samples of the asphaltic cement, properly labeled with brand or trade name, must be furnished for analysis which will be made under the direction of the engineer by a reputable chemist experienced in the analysis of hydro-carbons, and according to the result of this analysis it will be determined whether the asphaltic cement offered complies with these specifications and is suitable for the purpose intended. The brand or grade of asphaltic cement on which contract is awarded shall be used in the construction of the pavement. Analysis also may be made as often as the engineer may desire of the asphaltic cement after the contract is awarded and after the work is begun, and if any of the analyses should fail to agree reasonably close with the analysis of the sample submitted with the bid, the lot in question will be rejected. Sufficient time shall be allowed for tests to be made before the asphaltic cement is needed for the work.

Inspection

The County Superintendent of Highways and inspectors of State Highway Department shall at all times have access for inspection to all branches of the work on the street, at the refineries, or at the plant where material is stored, prepared, or being mixed; and the contractor shall furnish from time to time such samples of each separate ingredient, or combinations of the materials to be used in the improvement as may be requested by the County Superintendent of Highways.

When deemed necessary by the County Superintendent of Highways, the contractor shall store separately and in such manner as to admit of identification any or all materials which he proposes to incorporate in this improvement.

Requirements for Bituminous Binder

When tested in accordance with the methods described in Bulletin 314, United States Department of Agriculture, the bituminous binder shall conform to all of the following requirements:

The bituminous binder shall be free from water.

Specific Gravity—The specific gravity at 25° C. (77° F.) shall not be less than unity.

Total Bitumen—The bituminous binder shall be soluble in chemically pure carbon disulphide at air temperature to the extent of at least 95 per cent for the Bermudex products, 80 per cent for Cuban products, and 65 per cent for Trinidad products.

Naphtha Insoluble Bitumen—Of the total bitumen not less than 15 nor more than 28 per cent by weight shall be insoluble in 86° B. paraffin naphtha at air temperature. On evaporation of the naphtha solution, the residue obtained shall be sticky and not greasy.

Fixed Carbon—The fixed carbon shall be not less than 6 nor more than 14 per cent.

Penetration—The penetration of the bituminous binder as determined with the Dow penetration machine, using a No. 2 needle, 100 grams weight, 5 second time, and a temperature of 25° C. (77° F.) shall be not less than 5 nor more than 8 millimeters.

Loss on Evaporation—When 20 grams (in a tin dish 2½ ins. in diameter and ¾ in. deep, with vertical sides) are maintained at a temperature of 163° C. (325° F.) for 5 hours in a N. Y. testing laboratory oven, the loss shall not exceed 6 per cent by weight. The surface of the residue at air temperature shall be smooth and show no sign of blistering or cracking.

Flash Test—The flash point by the open cup method shall not be less than 163° C. (325° F.).

Brittleness Test—A cylindrical prism of the bituminous binder 1 centimeter in diameter, after being maintained at a temperature of 5° C. for 20 minutes shall bend 180 degrees at any point without checking or breaking. The bending shall take place in one continuous operation requiring not more than 10 seconds.

Specifications for Wearing Surface

The specifications covering the wearing surface are:

The asphaltic concrete wearing surface shall consist of an asphaltic cement, sand, limestone and mineral dust, so proportioned that the mixture will contain average proportions by weight of the whole mixture, as follows:

Bitumen			6½% to 8%	
Mineral--				
Passing	and Retained On			
200 mesh	... mesh		6% to 11%	
80 "	200 "		6% to 15%	
40 "	80 "		10% to 25%	
10 "	40 "		10% to 20%	
4 "	10 "		10% to 40%)	Total, 40%
2 "	4 "		5% to 20%)	to 55%

The items designated as passing 200 mesh sieve, include filler, fine sand passing a 200 mesh sieve, and such 200 mesh mineral as is naturally contained in asphaltic cement.

Reduction of Stone and Elimination of Seal Coat

On some of the roads first laid the mixture had almost the

maximum amount of stone specified, 55%, but it was found did not close up as much as was desired and had too open an appearance. This condition necessitated using a seal coat which was provided for in the first specifications. It was desirable to eliminate the seal coat, if possible, and the mixture was modified bringing the stone content down to near the lower limit, 40%. This gave a good close surface and required no seal coat which was eliminated from subsequent specifications, a cement swept finish being substituted. This 40 per cent stone mixture has shown very good results so far, and from all indications the roads laid with it should give excellent service.

Mixture Gradings

The following are a few of the mixture gradings:

	95th St.	Archer Ave.	147th St.	Higgins Rd.
Bitumen	7.9	7.1	7.1	7.0
Passing 200 mesh	8.7	10.3	9.1	9.9
" 80 "	15.1	8.3	8.7	8.8
" 40 "	19.7	18.8	15.4	16.5
" 10 "	7.0	14.6	13.5	18.7
" 4 "	18.3	25.1	20.8	16.3
" 2 "	23.3	15.8	25.4	23.8

At each asphalt plant the county places an inspector to control the mix. An inspector from the State Highway Department also visits the plant frequently, and samples of the mix and materials are sent regularly to the State Laboratory and to the writer's laboratory for analysis. Each car of asphalt and of flux is sampled and a complete analysis of the sample is made. All materials entering the work including the cement and stone in the base are inspected and tested before being used.

The roads have already received a large amount of traffic of all kinds, and while they have not been laid long enough to predict with certainty how long a life they will have, they have so far given no evidence of wear and their appearance would indicate many years of good service ahead which will fill a long-felt want in Cook County.

The Use of Modern Machinery in County Road Construction

By C. B. Scott, Assistant State Highway Commissioner, Richmond, Virginia

The question of the use of modern equipment in county road construction is a subject of great importance, particularly at this time when labor and material are both high in price and difficult to obtain. It is a subject which has so many ramifications that a volume might easily be written without exhausting it, said Mr. Scott in his address on August 7th, to the North Carolina Good Roads Association.

We, in the South Atlantic States, have heretofore had a comparative abundance of cheap labor and have therefore been prone to use labor where it would sometimes have been more economical to have used machinery. Now conditions have changed and labor is costly, and often cannot be secured at a reasonable price. As is always the case when the demand for labor is greater than the supply it becomes less efficient and more irregular, thus adding to both the cost and delays in the execution of work.

In a discussion of this nature it will be impracticable to give more than a brief description of the various modern machines and devices which are being used so advantageously in road construction, and point out some of the new ways in which they are being used.

For clearing right-of-way stump pullers are usually more economical than explosives and should be used when time will admit.

Slip Scraper Performance

Drag, or slip scrapers are made in the following sizes: No. 1, of 7 cu. ft. capacity; No. 2, of 5 cu. ft. capacity, and No. 3, of 3½ cu. ft. capacity. From 4 to 10 drag scrapers should be used to constitute a force, depending upon the length of haul. They are very efficient up to a haul of 100 ft. and can be used with economy up to 200 ft. Except when the material is soft it should be loosened by a plow or other suitable means.

A two-horse team and scraper can move the following amounts of loose material in a working day of ten hours, on the average:

For a haul of 25 ft., 70 cu. yds.
For a haul of 50 ft., 60 cu. yds.
For a haul of 100 ft., 50 cu. yds.
For a haul of 150 ft., 40 cu. yds.
For a haul of 200 ft., 35 cu. yds.

Wheel Scrapers

For hauls of from 200 ft. to 800 ft. wheel scrapers are efficient. They are made in four sizes: No. 1, of 10 cu. ft. and No. 3 of 17 cu. ft. capacity; No. 2½ of 15 cu. ft. capacity and No. 3 of 17 cu. ft. capacity. A snatch team is used for loading No. 2 wheelers, except in very soft material, and in almost all cases for loading No. 3 wheelers. They should be worked in gangs of from 4 to 6 for hauls up to 400 ft., and the number increased with the length of haul.

In a working day of 10 hours a two-horse team and scraper can move, on the average, the following amounts of loose material:

For a haul of 100 ft., 60 cu. yds.
For a haul of 200 ft., 50 cu. yds.
For a haul of 300 ft., 40 cu. yds.
For a haul of 400 ft., 30 cu. yds.

Neither drag nor wheel scrapers will carry loads equal to their rated capacity, and in rough materials the loads are often considerably reduced. In the construction of embankments with scrapers the embankments are compacted to such an extent that there is little future settlement, which is of considerable advantage where a pavement is soon to be laid.

Of recent years the Maney four-wheel scraper has come into use. It has the advantage of carrying a load from 1 to 1½ cu. yds., and can be used economically for hauls from 200 ft. to 2,000 ft. A tractor or hoist is best for loading, but a snatch team can be used for that purpose.

Road Graders

Road machines, or graders, are made in many styles and weights. The light two-wheel style is used largely for very light grading and shaping. A very heavy four-wheel machine is being used in this section for quite heavy grading and bids fair to be a great labor saver. In the construction of broken stone and gravel roads a road machine can often be used for shaping the roadbed and for spreading the stone or gravel, thus considerably reducing the amount of labor used.

Elevating graders, which have been successfully used in excavating irrigation canals in the western states, may be found suitable for road construction under some conditions. They are made in three sizes—large, standard and small—and require from 10 to 16 horses for motive power, or a tractor of equal power.

Trench Excavators

Trench excavators may find a place in road construction where it is necessary to construct a considerable amount of drainage ditches, particularly when the work is done in cooperation with adjacent property owners. The continuous bucket or wheel type of excavator is probably best adapted to work of this character. These machines are made in several styles and sizes.

Steam Shovels

Steam shovels of the revolving and sliding beam type are

adapted to grading and in heavy work should prove decidedly economical. In stone quarries they may be used to advantage in loading stone into cars for crushing, or, where it is necessary to store large quantities of stone in piles, for reloading it.

Industrial Railway Equipment

Narrow-gage locomotives and cars can be used economically more often than is generally supposed, particularly in hauling stone, gravel, sand, etc., for broken stone roads of bituminous or cement concrete construction.

Dump and spreading wagons are very useful and great labor savers, where the length of haul is not too great. The various types are too numerous to mention, though the essential features are practically the same.

Motor Trucks and Trailers

Motor trucks and trailers are rapidly coming into use and are proving satisfactory. For construction purposes somewhat larger trucks are generally preferred than where they are to be used for maintenance. It is usually best to purchase trucks of the same make, where a number are required, to facilitate the interchange of repair parts, and, where only a few are purchased, it is well to select a make which maintains a service station in the vicinity. When desirable, a truck can be advantageously used for pulling a plow, road machine or bituminous distributor.

Tractors

Tractors are superseding teams to a considerable extent for plowing, road machine work, hauling bituminous distributors, etc. They can also be used for operating a stone crusher for repair work, if equipped with a belt wheel, when not used for traction, and have the advantage of costing very little when not in use.

Drills

Standard steam drills are almost essential for quarrying stone or excavating considerable quantities of it in the roadway. Air drills of the hand type are useful in breaking large stones in quarries and for drilling rock in side ditches and for light rock excavation where they must be moved frequently.

Stone Crushers

Stone crushers may be considered a necessity for the construction of broken stone roads, and it has been quite a revelation to many of us to learn that they were being so seldom used by the European nations in the construction and repair of military highways. For construction purposes the 10x20-in. size will generally be found most serviceable and there are several makes which are very satisfactory.

Hoists

Hoists, with cable and cars, for transporting stone from quarries to crushers, and for similar purposes, will usually be found much more economical than wheelbarrows or carts. Frequently such a hoist can be operated by an additional wheel on the shaft of the crusher engine.

Sprinklers

Sprinklers for watering macadam and similar roads are very useful. They should be of the cut-under type to permit turning in a small space, and about 400-gal. capacity will generally be found most convenient. Where water from streams is to be pumped directly into the tank it is best to have spraying devices so arranged as to permit passage of the fine sand and small twigs and leaves, otherwise much time is lost in cleaning the sprayers and the caps become battered and worn in handling.

Scarifiers

Scarifiers are great savers of labor in the reconstruction of broken stone and gravel roads. Several satisfactory types are made and rollers are being made with scarifiers attached to the rear. The latter machines have the advantage of doing very uniform work and can be set to any depth desired, but will not operate up very steep grades for lack of sufficient power.

Rollers

Rollers for compacting the embankments and rolling the sub-grade and surfacing material are a standard part of road equipment and have been developed into very satisfactory and efficient machines. The three-wheel type of 10 to 12 tons weight is usually preferred. They are propelled by steam or gasoline, as may be preferred.

Bituminous Distributors

Bituminous distributors, either horse-drawn or motor-driven, are more economical and satisfactory for applying bituminous material than hand work, where a considerable amount of material is to be used. For horse-drawn vehicles about 600 gals. capacity is convenient and such machines should be equipped with heater and pump. Motor-driven vehicles are more elaborate in design and equipment, depending upon the use and amount of work to be done.

Concrete Mixers

Concrete mixers of small size are very useful for constructing end-walls for drain-pipes, culverts and small bridges. Larger mixers are convenient and economical for use in building large bridges, retaining walls, and in laying concrete pavement. The size and type desirable depends upon the purpose to which it is to be put.

Stone Bins, Elevators and Screens

Stone bins, with elevators and screens for separating stone and gravel according to size, and storing it temporarily, are very useful and the portable type usually is most economical. About 30 tons capacity, depending upon the size of the crusher, is usually most convenient.

Unloaders

Unloaders, operated by motor power, for loading materials from bottom dump cars into wagons and trucks, have been developed into very useful and economical machines, where a considerable quantity of material is to be handled. Another machine of a similar type is used for loading stone from piles. For unloading open top cars into wagons and trucks, car or skip loaders are great savers of time and labor. The 1½-cu. yd. capacity is generally to be preferred. This device is attached to the outside of the car and when loaded is dumped into the wagon or truck.

A public official, who accepts responsibility for the expenditure of money and labor, is in duty bound to make every effort to use the means placed at his disposal in the most efficient manner. He should be mindful of the fact that prison labor is the equivalent of money and he should not waste it, or permit it to be wasted by local road officials, where he has control of it. When work is done jointly by the state and counties it is sometimes the case that local officials are inclined to use prison labor too freely to avoid the expenditure of local funds for the purchase of proper equipment.

Under the discipline of a world war we are learning that waste and inefficiency are crimes, which are paid for in agony and death, and no one who has the welfare of our country at heart can be unmindful of his duty to utilize the means at his command to the best of his ability.

Overcoming the Heaving of Creosoted Wood Block Pavements

The swelling and subsequent heaving of creosoted wood block pavements can be practically overcome by placing the paving blocks directly on a concrete base painted with a bituminous coat. The condition of the various pavements, so constructed, which have been in service from two to seven years in middle western cities justifies this conclusion.

Paving blocks laid in this way, and properly spaced, with bituminous filler, have a waterproof coat on five of their six surfaces. This provides a degree of imperviousness which safeguards the blocks from the swelling resulting from water absorption.

The development in paving engineering here discussed is of prime importance, as the swelling and resulting heaving of wood block construction have been the inherent defects of that class of constructing. These are the defects usually advanced in arguments against the use of creosoted wood block pavements. The type of construction here described also eliminates the disturbance of the surface of the finished pavement caused by the shifting of the sand-cushion or by the improper preparation of the mortar-bed.

The Practice Not New Abroad

This practice of laying creosoted wood blocks immediately on a properly finished concrete base has been used abroad for many years both with and without a bituminous coating on the base, however, because of the difficulty of securing a smooth surface on the concrete base it was until recently considered impracticable in this country to lay blocks in this manner. Recent developments in the finishing of concrete pavements and concrete pavement bases have finally overcome this objection. Smooth surfaces on concrete bases are now readily obtained.

The method under discussion was first used in this country some seven years ago in a small city and subsequently by certain large cities including Chicago, Pittsburgh and St. Louis.

The City of Detroit is extensively using the bituminous coating cushion with good results. During the present year this method was also employed successfully in Milwaukee and Cleveland. Last year Toledo used this method in constructing 25,000 sq. yds. of paving, much of which is for paving in car tracks.

Procedure in Applying the Method at Toledo, Ohio

In the Toledo work mentioned, the concrete foundation was brought to a smooth surface and floated with a light concrete roller. This is the familiar roller method of finishing a concrete surface and is effective as the roller compresses the concrete and so squeezes out the excess water, producing a smooth surfaced base of uniform and high density. The base was allowed to set for five days and the surface was then given a paint coat of cold pitch (of a melting point of approximately 140 degrees Fahrenheit). This coat was poured on the foundation and spread with a squeegee. As soon as the pitch hardened the blocks were placed directly on it and the joints filled with pitch to within 1 in. of the surface. The filler was very hot while being spread over the blocks by means of the squeegee; this high temperature reduced to a minimum the quantity remaining on the upper surface of of the blocks. It is permissible to fill the joints completely at the first application for when the pitch cools about 1 in. of space will be left in the top of the joints. These spaces are then filled with dry sand, the purpose of which is to prevent the squeezing out of the pitch in hot weather. Unless this precaution is taken the pitch will be forced out to the surface of the street in large quantities owing to the high coefficient of expansion of pitch. The sand in the upper portion of the joints forms a mastic which holds the pitch below in place.

The ordinary construction was reversed in the street car tracks and dummy strips where a crown in the pavement is usually placed. The surface was made concave instead of convex and track drips were placed at 300 to 400 ft. intervals. The crown in the street car track in ordinary construction throws the water toward the rail and it percolates under the pavement with subsequent damage to the pavement. On the other hand a concave surface throws the water to the center of the track, where it passes to the track drips and thence to the sewer. In pavements constructed last season the depth of the concave surface was 1 in., but this year it has been increased to 1½ ins. It should be noted that this concave type of construction for car tracks is satisfactory only where there is sufficient longitudinal grade to carry the water off. Pavements constructed in this manner gave satisfactory service in Toledo last winter.

Comparative Cost

The cost of this type of construction is somewhat less than that of the familiar mortar-bed type. The smooth floating of the concrete surface to the desired degree of smoothness and regularity is now a simple process. The paint coat of pitch requires about ½ gal. of pitch to the sq. yd. of surface. The cost of labor and materials is decidedly less in this type of construction than in the mortar-cushion type. Experience so far has indicated that coal-tar pitch gives better service than asphalt, both for the coating and the filler. Tar adheres better to the concrete foundation than does asphalt and holds the blocks more firmly in position, while asphalt used as a bituminous coating on concrete may be peeled off in large sections with ease; it requires a pull of about 150 lbs. per square inch to loosen the blocks where pitch is used. If a paint coat of light oil is applied to the concrete before the cushion coat is applied asphalt can be used successfully.

The Choice of Fillers for Block Pavements

By John S. Crandell, Consulting Engineer, The Barrett Co., 17 Battery Place, New York, N. Y.

On the selection of the proper filler for pavements of the block type often depends the success or failure of the pavement. Too little attention has been paid to this very important factor, and many of our city pavements show plainly the lack of thought on the subject. It is common to hear a city spoken of as "a grout filler town," or "a pitch filler town." It will be found that the engineer of such a city has decided in his own mind that one certain kind of filler is the best, and he uses nothing else, although it could be easily demonstrated that some pavements require different treatment from others.

Types of Fillers

Perhaps the best way to compare the behavior of fillers is to take up each type of block pavement in turn, first defining the fillers used.

Sand Filler: Porbably the first filler ever used.

Pitch Filler: (Also called Paving Cement). Coal tar pitch made from refined coal tar, melting point between 110 to 150 deg. Fahrenheit (cube in water). This filler is used without the addition of other material in brick and wood block pavements. For granite block, pebbles are first swept into the joints. (See Granite Block, below.)

Pitch Mastic Filler: A mixture of coal tar pitch and fine sand in equal amounts. It can be used in all types of block pavements except plain rectangular wood block.

Asphalt Filler: A refined oil or natural asphalt, penetration 35-60. Used the same as pitch filler.

Asphalt Mastic Filler: A mixture of refined asphalt and sand in equal amounts. It is used like Pitch Mastic Filler.

Cement Grout Filler: A mixture of Portland cement, sand, and water. It is used in stone block and brick pavements.

These fillers are the ones usually used. Others have been tried from time to time, but have been discarded in favor of one or more of the foregoing. One filler that gave promise of excellent results was a sulphur and sand mixture. The objection to it was the extreme care necessary in heating the sulphur; only a carefully trained man could handle the mixture successfully, and after numerous failures it was given up. Premolded strips of bituminous materials have been tried, and some of them are in successful use as expansion joints, but they are not satisfactory for the bulk of the pavement.

Functions of a Filler

First of all, a filler should make the joints waterproof. If it fails to do so, then sand is as good a material as any, for all other functions are secondary considerations. Protection of the joints, foothold for horses, insulation against noise.

ease of removing and replacing blocks when cuts are made in the pavement, use of the pavement immediately after the filler is in place—all these will suggest themselves to the engineer as desirable qualities that a filler should have. While these are important they are by no means so necessary as the waterproofing value.

Granite Block Pavement

Pitch and Pebble Joint Filler—For many years the pitch-and-pebble joint filler was the only one known. Properly applied it is an excellent filler, and a better one has not been found for pavements laid with wide joints. Cincinnati uses this type at present even with close joints, and the results are good because the work is done right. Here the blocks are laid on a 1 in. sand cushion, and after laying, they are pinned with clean gravel which will pass a ½ in. circular opening and be retained on a ¼ in. opening. Much care is taken to secure a gravel that will pass this specification. Enough of it is swept into the joints to half fill them. Instead of then ramming the blocks they are rolled with a tandem roller. Hot coal tar pitch is poured into the joints so that they are half full. This is followed by a second application of gravel, which all but fills the joints, when a second pouring of pitch is made, completely filling them. Gravel is then cast over the surface, after which a flush coat of about ½ gal. of pitch per square yard is poured over the gravel, completely covering the pavement. Finally, finer gravel is strewn over the pitch flush coat, and rolled with a steam roller. The pavement is immediately ready for traffic. This is the correct way to make a pitch-and-pebble joint. There is no doubt about it being waterproof, and the experience Cincinnati has had proves it to be a filler admirably adapted to the use to which it is put.

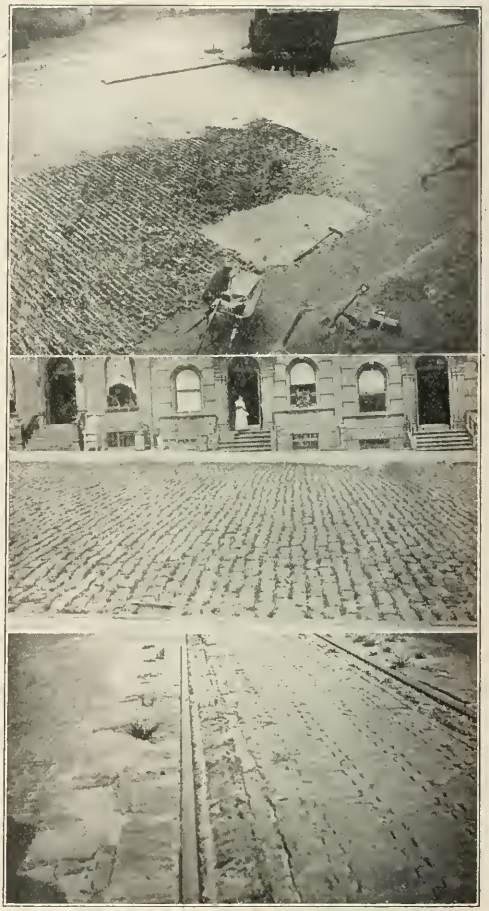
There are many miles of granite block pavements laid over 20 years ago in different parts of the country that have pitch-and-pebble joints in which the pitch is as lively today as when it was poured. Failures with this filler occur when, instead of filling the voids in the pebbles with pitch, sand is swept in on top of the pebbles, and a thin coating of pitch is spread over the top of the joint, or the pebbles are damp and wet. Good inspection will prevent such work.

Very little asphalt-and-pebble filler has been used, so that there is no opportunity for comparison to be made with pitch-and-pebble filler.

Pitch Mastic Filler—Pitch mastic filler was introduced in the United States in 1913 for use in modern granite block, where the joints are ½ in. or less in width. For these narrow joints pitch-and-pebble filler is unsuited, and a mixture of fine sand and paving pitch in equal amounts, by volume, was tried. The results have been very satisfactory when the mixture has been properly made and introduced into the joints. The qualities necessary in the ingredients are that the sand shall be fine and heated to 300 deg. F., while the pitch shall be of the correct melting point for the grade of the street, and have the correct free carbon content. The specifications of the American Society of Municipal Improvements should be followed, both for pitch mastic and for asphalt mastic.

Asphalt Mastic Filler—Asphalt mastic was introduced about 1915 in New York City. It has given good results when properly mixed and used. It is, however, more difficult to mix than pitch mastic due to the fact that asphalt should be heated to about 350° F. while pitch works best at 250° F. This also makes the operation of filling more difficult, as the asphalt mastic will not flow to the bottom of the joints if it drops below 275° F. In such cases the tops of the joints are "buttered" and the bottoms are empty. Pitch, on the other hand, flows to the bottom of the joints even at ordinary temperatures, thus sealing the joints at the bottom. This property has led some engineers to think that the pitch has left the joint entirely, but such is not the case. The asphalt mastic, by staying at the top of the joint, fails to show the condition at the bottom and for a while makes the pavement look better than the more perfectly filled pitch mastic joint.

An interesting experiment was tried on 31st and 32nd streets, between 3rd and Lexington Avenues, New York City in 1916. Modern granite block was laid on both streets. One-half of the joints of the paved area on each street was filled with pitch mastic, and the other half with asphalt mastic. An examination made recently shows that there is little difference. Both seem to be standing up well under the heavy mixed traffic.



FILLER IN BLOCK PAVEMENTS.

Upper View: Rush St., Brooklyn, N. Y., first Job of Pitch Asphalt Sand Filler. Pitch and Asphalt Mixed on Street in Kettle. Granite Block. Middle View: Grass Growing in Sand-filled Joints in Granite Block Pavement, East End Ave., New York City. Lower View: Brick Pavement 20 Years Old, with Sand Filler, on Madison Ave., Montgomery, Ala. Ties Have Rotted and Rail Movement Pumps Sand Out.

The Borough of Brooklyn, New York City, has been using since 1917 a mastic, the bituminous portion of which is composed of 4 parts coal tar pitch and 1 part asphalt. The pitch has a melting point (cube in water) of about 115° F., and the asphalt has a penetration of 35. The melting point of the mixture is about 145° F. To date the results have been very satisfactory.

Grout Filler—Portland Cement grout has been used in many cities as a filler for granite block pavements. In some it is an unqualified success, while in others it is unquestionably a failure. Some of the failures are due to faulty mixing and applying. Some are due to the quality of the granite, the climate, and local conditions. Some are caused by failure to realize that grout should never be used in pavements on heavy traffic streets liable to be torn up frequently, such as those in the Borough of Manhattan, New York, or the Loop district in Chicago. Assuming that the grout has been properly mixed and applied, it will be found that soft blocks will very soon shatter and fail, due to the non-yielding filler which is harder and stronger than the blocks themselves. If soft blocks are scattered through the pavement, there will be here and there spots that sooner or later are going to become holes. When cuts have to be made it is impossible to remove the blocks without breaking them, it

VIEWS ILLUSTRATING USE OF PITCH FILLER FOR BLOCK PAVEMENTS.

Renapt Granite with Pitch and Pebble Filler. East Pearl St., Cincinnati, Ohio. Old Granite Block Laid About 15 Years Ago on Columbus and Manhattan Avenues, New York City. Note Pitch Sticking to Blocks.

the grout is of good quality, and if it is not good the pavement will not be waterproof. Again, it is impossible to repair the cut pavement so that the cut does not show. For this reason streets in undeveloped sections, or districts that are growing should never be paved with a grouted block pavement. Grout should be allowed at least 10 days to set. This precludes its use in pavements in business districts. As against these instances we have the splendid grouted granite block streets of Havana, Cuba. An excellent grade of Swedish granite, combined with good grout and a warm climate, make for perfection. Perfection, however, is not attained, for there is a disagreeable rumble and roar heard when iron tired drays traverse the pavements. This same racket has been very disagreeable in Boston where grout has been used; here a bituminous filler is used along the curb to prevent the vibration of the monolithic pavement being carried into the office buildings.

Durax

Durax pavement consists of small cubes of granite laid on a dry mortar bed. Undoubtedly the best filler for this pavement is a mastic. Grout is not satisfactory.

Medina Block

Medina sandstone is not hard enough to take very heavy traffic. It is not strong enough to stand internal stresses set up when grout is used, and almost all grouted Medina sandstone pavements have shattered areas. It does not cut regularly enough to give a close joint, and hence the pitch-and-pebble filler is the best that can be used. Pitch mastic and asphalt mastic have given satisfaction.

Brick

Undoubtedly the first filler ever used in brick pavements was sand. The writer has examined many miles of brick pavements in Holland and Belgium with sand filled joints which are upwards of 75 years old. These pavements are sometimes cited to show what wonderful results can be obtained with paving brick and a simple sand filler. But these same pavements, if subjected to the traffic of a modern American city, would not last a month. The writer recorded in his diary (1912) that during two full days spent on some of these brick highways leading out of Amsterdam only five motor cars were counted, and no motor trucks. The traffic consisted of dog-carts, and light horse drawn wagons carrying vegetables, milk and cheese. There are a few cases of sand filled brick pavements in this country that have lasted well, and are today in good condition. But they are exceptions. All engineers are agreed that something better than sand is necessary.

Opinion is divided between the advantages of soft fillers, i. e., pitch or asphalt, and cement grout. This is due to the fact that there have been many successes and failures with both types. Pitch was probably the first filler used after sand, and in the early days of the tar industry there was no laboratory control of the output. The result was that the right grade of pitch was not always supplied for the job. Today, when a proper specification can be met by any well-equipped plant, there is no excuse for not getting the right quality and grade of pitch. Yet often a contractor orders a hard roofing pitch for a paving job, and complains if it chips out of the joints in cold weather. A paving pitch of the right consistency will insure a watertight pavement.

Some of the early blown asphalt fillers were worthless. They had no adhesive strength, and could be lifted out of the joints in strips; such fillers did not prevent the entrance of water. Today a better grade of asphalt can be had, and if the specifications of the American Society of Municipal Improvements are followed a satisfactory filler will be the result.

If the bricks have well defined lugs, or are of the vertical fibre type, a mastic filler is preferable to either plain pitch or asphalt. There is less tendency for a mastic filler to run out of the joints, as the sand tends to stiffen it.

In spite of the large number of failures of brick pavements due to cement grout filler, an enormous yardage is laid every year with this material. The reasons are that grout is cheaper than a soft filler, it is easy to use and the street presents a good appearance when it is new.

There are numerous examples of grouted brick streets that are in excellent condition after many years' use. There are more examples that are far from being satisfactory. Usually brick streets and roads less than 20 ft. wide stand up well when grouted. Wider streets are less satisfactory, because of the danger of cracks appearing, and the rumbling of traffic when the brick are laid on a sand cushion. Blow-ups, while

not common, do occur from time to time and are a source of danger and annoyance. It has been held that grout protects the edges of the joints better than a soft filler. This is true, but it is also true that if the brick are of the best quality the edges need no protection; and further with the increasing number of rubber tired vehicles and the rapid retirement of horse drawn traffic the edges do not require the protection that formerly was thought necessary. What was said of shattering of the surface in grouted granite block pavements is even more applicable to those built of brick. A soft brick starts the process, and soon a rather large area has failed. It is a very difficult matter to patch a grouted brick pavement successfully, and the countless bad patches verify this. It can be done, but only by experienced men and at the cost of considerable care and expense.

Wood Block

There seems to be more unanimity of opinion over the filler to be used in wood block pavements than with any other kind. Most authorities agree that coal tar pitch is the only satisfactory filler.

Sand is favored by a few engineers of experience if the traffic is heavy enough to broom out the top of the blocks so as to make a tight joint. Market Street, Philadelphia, and Washington Street, New York, are good examples of this. But unless the traffic is exceptionally heavy, the pavement will fail, for it is essential that a wood block pavement be waterproof.

Grout has been tried, but within a few days after it has been in use the grout has broken up into small pieces, so that its waterproofing value is zero. To use grout in wood block pavements is to waste money.

Asphalt has been used to some extent, but it is not a success. The creosote oil with which the blocks are treated has a softening and disintegrating effect on the asphalt, so that its waterproofing value is lessened, and its stability is reduced. In the course of time it loses all value as a filler.

Coal tar pitch is a true waterproofing agent for creosoted wood blocks. A pitch of proper melting point (140°-150° F.) must be used. The action of the creosote in the blocks is to cut back the pitch, or soften it and thus lower its melting point, without changing in any way its quality. It is for this reason that a high melting point is desirable at the beginning, since after a year in the pavement the pitch will be found to be of lower melting point, and hence capable of permitting easy expansion and contraction of the blocks. Disagreeable bleeding is prevented if the blocks are properly treated, if they are laid hand tight without ramming, if the joints are not filled more than two-thirds with pitch, and if the surface is sanded.

Summary

On the whole there have been fewer failures and better work when block pavements have been laid with soft or bituminous fillers than with sand or grout. There is undoubtedly greater waterproofing value in bituminous fillers than in cement grout. A greater number of desirable qualities are inherent in the bituminous fillers than in grout.

(Engineers who have studied the performance of various types of fillers in block pavements are invited to express their views on this subject.—Editor.)

SEWER DESIGN AND CONSTRUCTION

Sewage Collection and Disposal Proposed at Los Angeles Harbor

By W. T. Knowlton, Engineer of Sewers, Los Angeles, Calif.

In connection with the delevopment of the Harbor District of Los Angeles, the matter of sewers and sewage disposal received early attention as it was realized that without such improvements the development of the Wilmington and Terminal Island Sections in this part of the city could not progress very much. Accordingly plans were made for both the collection and treatment of sewage in these two portions of the Harbor District shortly after these sections were consolidated with the city of Los Angeles.

In Wilmington it became necessary to raise the level of the land adjoining the water front between 7 and 8 ft., before a proper drainage system could be installed. Prior to this being done sewers were laid in the business portion of the Wilmington District, the outlet for these being into the Wilmington basin at the foot of Fries Avenue and Canal Avenue.

Existing Plant For East Wilmington

Later plans were prepared and a sewerage system installed for the easterly part of Wilmington, so that the sewage from this part was collected at a disposal plant at the easterly end of the east basin of the inner harbor and there treated before discharging into this basin. This plant has now been in operation about three years, and consists of a pumping plant, Imhoff settling tank and sludge bed. Since its completion the plant has given satisfactory results, no odors therefrom being noticeable. The amount of sewage treated by this plant is approximately 150,000 gals. per day, the population served being approximately 1,000 people. It will be noted that the amount of sewage pumped may show the presence of ground water, which is due to the fact that the lower portion and outlet of the sewer into the sump chamber of this pumping plant is about 8 ft. below mean low tide.

Shortly after this East Wilmington plant was installed it was considered that a similar treatment should be applied to the sewage from the other portions of Wilmington as well as to the condition on Terminal Island. To provide for this work, bond issues were proposed which included a similar treatment of the sewage of San Pedro. As, however, bond issues for other matters than sewage treatment were considered at the same time, the election held in 1916 for sewer bonds failed to obtain the necessary number of votes, and a similar result occurred in the following year, when a second election was held for sewer bonds under similar conditions.

Plans for Collection and Disposal

During the present year, however, the conditions at the harbor concerning the matter of sewage disposal are once more receiving considerable attention, due mainly to the necessity of providing sanitary conditions for the housing of those employed at the shipyards at the harbor. In a report of the housing conditions made in April by the State Commission of Immigration and Housing, it is stated that to accommodate the workers in the shipyards a large number of houses should be erected as under the present conditions these workers are obliged to travel many miles each day in going from their homes to work. As a result of these conditions, the writer has been instructed to prepare the necessary plans for the collection of sewage in both the Wilmington and Terminal Island Districts..

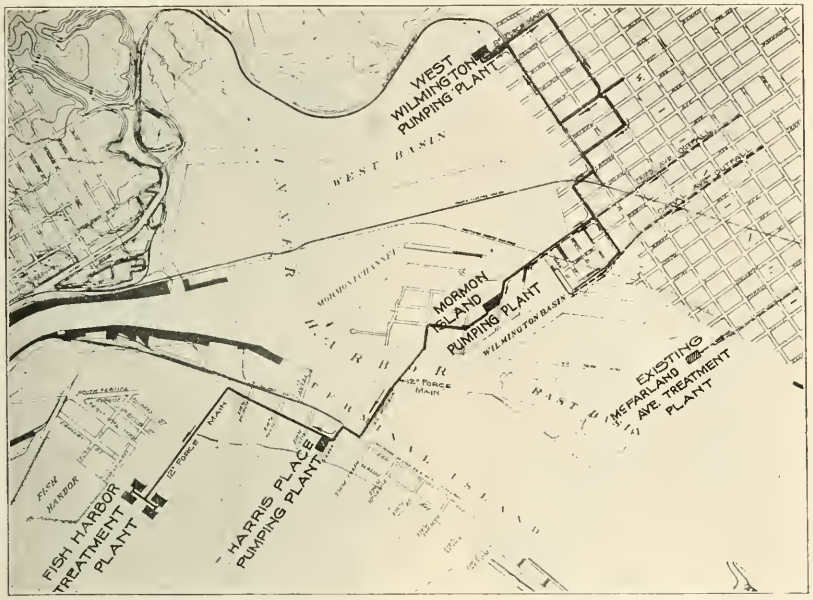
Cannery Wastes

At the present time, as above noted, the sewage from the central or business portion of Wilmington is discharged in a crude condition into the upper end of the Wilmington basin. This condition in itself has not caused especial objection, but with the growth of the canning industry in this vicinity, and the lack of a proper method of treatment, it has been found that the harbor waters at the mouth of the outfall sewers as well as that along the wharfs at the north end of Mormon Island have become so polluted that there is not sufficient oxygen therein to prevent the material discharged from causing obnoxious odors near the mouth of the outfall sewers and adjacent to the discharge from the canneries. To remedy these conditions it has been planned to collect all sewage now discharged from the Fries Avenue and Canal outfall sewers as well as that which is discharged from the canneries and convey this sewage, as well as that of the West Wilmington District, to a pumping plant proposed to be installed on Mormon Island. At this plant the sewage would have all sand and screenings intercepted before discharging into the pumps, which would force the sewage therefrom across the channel between Mormon Island and Terminal Island and into a treatment plant proposed to be installed about one-quarter of a mile east of Fish Harbor on land proposed to be reclaimed by the city for commercial and industrial purposes. At the present time this land has a depth of water along the ocean front 10 ft. or more below low tide, which will indicate that foundation work will probably be required in the installation of the settling tanks proposed for this site. It is also planned that the force main to be laid between the Mormon Island pumping plant and the treatment plant at Fish Harbor will intercept the sewage collected on Terminal Island, and thus provide for a long needed installation of a sewerage system in this section of Los Angeles.

The population benefited by this proposed work at Wilmington and Terminal Island is at the present time but a fraction of that which is anticipated, and provision has been made for an ultimate population of 10,000 people. The estimated cost required for the construction of the necessary pumping plants in Wilmington and Terminal Island together with force mains and with the settling tanks and sludge beds required at Fish Harbor is $135,000 and a request that this sum be obtained for this purpose has been sent by the Board of Public Works to the City Council. The accompanying plan shows the location of the work proposed. It might be added that consideration has been given to other means of treatment than that adopted and also, that due attention has been given to the location of the disposal site.

Discharge of treated sewage into the main channel of the inner harbor has some merits; however, this disposal is not as satisfactory as that proposed at Fish Harbor, where the tidal current will properly dispose of the treated effluent when discharged at a proposed depth of 15 ft. below low tide.

As only tentative plans for this proposed treatment of sewage have been made, details concerning installation of this work cannot at this time be given.



LOCATION OF PROPOSED SEWAGE DISPOSAL PLANTS AT WILMINGTON AND TERMINAL ISLAND, LOS ANGELES, CALIFORNIA.
Existing Sewers in Dotted Lines. Proposed Sewers, Force Mains and Disposal Plants in Solid Lines.

Conditions Calling for Separate or Combined Sewers

The separate and combined system of sewers each has its advantages, and the question of which system is the best adapted to any given locality requires careful consideration of the influencing factors, a number of which are here enumerated as stated in the report of Alvord & Burdick to the city of Billings, Mont., upon the extension of the storm water sewer system.

Separate System of Sewers

Among the conditions which indicate that a separate system of sewers is desirable, may be mentioned:

First—Where storm water does not require extensive underground removal, or where it can be concentrated in a few shallow underground channels.

Second—Where drainage areas are short and steep, facili-

tating rapid flow of the water over street surfaces to the natural water courses.

Third—Where the sanitary sewage must be pumped and the additional cost of pumping even a small amount of storm water is great. In this case especially is it true that if the overflow of storm water into a water course is not permissible, the separate system has great advantages.

Fourth—Where the sanitary sewage must be purified and storm water in a combined system either purified or by-passed—either scheme requiring large purification plant capacity or creating nuisance due to the overflow of objectionable refuse.

Fifth—Where the sewers are being built in advance of the city's development to encourage growth, the sanitary system provides a maximum of miles of sewers for a minimum expenditure. The storm sewers if ever required, may be built later, and rarely need cover over about one-half the area covered by a sanitary system.

Sixth—Where an existing sewer is laid at grades unsuited to receive sanitary sewage, it may frequently be used as a storm sewer.

Seventh—A combined system must usually be relatively of larger capacity than a separate storm drain for the same area, and the reason for this is that a storm drain may be overloaded at long intervals with slight inconvenience, whereas, on account of basement connections and the sewage carried by a combined sewer, any overflow is accomplished by great nuisance and complaint.

Eighth—The separate system has greater advantages in districts where the population is not dense, and where the proportion of sewage to rain water will always be relatively small.

Combined System of Sewers

Among the conditions which indicate that the combined system is desirable, are:

First—Where it is evident that both storm water drains and sanitary sewers must be fully and completely installed throughout the entire district, the total cost will be greater for the separate system than for the combined system.

Second—Where no pumping or purification is required at present or is anticipated in the future.

Third—Where the district is densely built up and the proportion of sewage to rain water is great. There is a further advantage of the combined system in closely built-up sections, on account of the fact that surface washings are present in greater quantity, and if they are carried into combined sewers decomposible matter will be deposited in the sewers, causing nuisance after the storm water flow has ceased.

The selection of which system of sewers to adopt obviously does not follow any hard and fast rules. It is frequently found that portions of a city can be best sewered on the separate plan, while other portions of the same city can be best sewered on the combined system.

WATER WORKS DESIGN AND CONSTRUCTION

Increase in Water Consumption in Certain Massachusetts Municipalities

By Bertram Brewer, Formerly City Engineer and Superintendent of Sewers and Water Works in Waltham, Mass., Now Special Asst. Engineer, Massachusetts State Department of Health, Boston

The writer has recently had occasion to investigate the current general increase in water consumption in some Massachusetts cities and towns. For purposes of comparison, a table has been prepared which includes also the Metropolitan District of Boston. Populations and a comparison of consumption records for the months of May and June, 1917, and May and June, 1918, are shown in Table I.

Table I.—Populations and the Percent. Increase in Water Consumption for May and June, 1918, over May and June, 1917, in Massachusetts Cities

	Population.	% Increase, 1918.
Stoneham	7,750	*
Fall River	125,000	3.5
Everett	40,550	4.9
North Andover	6,100	5.0
Chelsea	47,350	11.0
Waltham	32,000	12.0
Boston	788,000	13.7
Lawrence	106,000	14.0
Somerville	92,600	14.9
Met. Dist. Boston & vicinity	1,237,000	16.5
Revere	29,100	19.3
Belmont	9,200	19.7
Lexington	5,900	24.9
Milton	9,200	27.3
Melrose	17,800	28.7
Malden	52,000	29.8
Winthrop	14,500	33.2
Swampscott	7,900	36.8
Medford	34,400	37.0
Watertown	18,400	42.0
Arlington	16,800	46.3
Nahant	1,500	75.3
Quincy	44,000	75.8

*Stoneham's increase for May was 9%. In June there was a decrease of 4.3%.

The percentages are approximate only and the figures of population do not include summer residents or increases due to the war.

It is interesting to note that of these 22 communities only one, Stoneham, has shown any saving in water consumption over 1917. The increase runs as high as 75% in the little town of Nahant, which is solely a residential community on the sea coast. Some of these increases are plainly largely due to war work as at Watertown and Quincy. Strange to say, the large manufacturing cities of Fall River and Lawrence are away down in the list, but this is no doubt due to the fact that most of the large manufactories have their own private water supplies.

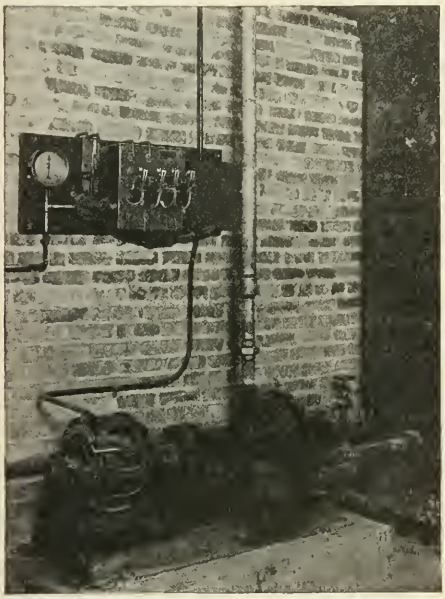
A resume of the published figures for consumption in the Boston Metropolitan District shows a noteworthy, almost steady decline in consumption from 1908 down to and including 1915, from an average of 128 gals. per capita to 88 gals. In 1915 the decrease was 4.96%. In 1916 when war work began to be a considerable item, there was an increase of 1.01%, in 1917 a further increase of 1.1%, while on the May and June basis there will be an increase in 1918 of 16.5% over 1917. The bulk of the increase cannot be due to the war and this table speaks for itself. The conclusion is obvious that the severe

weather of last winter has left in its trail a problem of leak finding for the Massachusetts communities at least, that will take the best skill on the part of those in charge to solve. Water works superintendents have a patriotic work to do of no small moment because these millions of gallons of wasted water are directly related to the coal pile and the winning of the war.

The Remote Control of Motor-Driven Pumps and Compressors

By F. M. Nourse, Engineer, The Cutler-Hammer Mfg. Co., Milwaukee, Wis.

Remote control of motor-driven machinery is probably more extensively used with pump and compressor applications than with any other class of machinery. The purposes for which the pumps and compressors are used as well as the

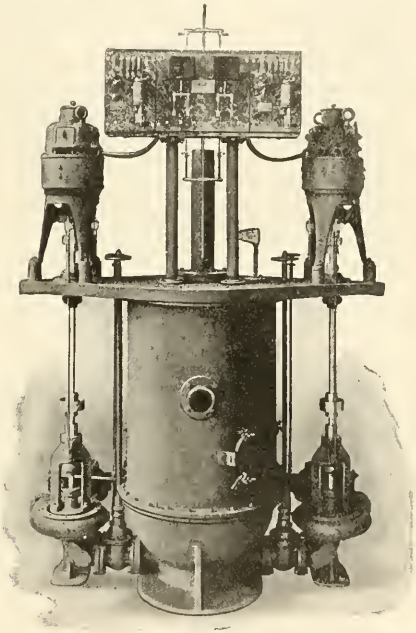


THREE H. P. 3-PHASE MOTOR DRIVING HOUSE PUMP CONTROLLED BY PRESSURE REGULATOR AND SELF-STARTER MOUNTED ON WALL.

methods of controlling them vary a great deal yet in general the main object is to change the water or other fluid from one level to another; or in a closed system to do the equivalent by increasing or decreasing the pressure. To enumerate all of the different applications of pumps and compressors would require a great deal of space. However, those applications with which we are most familiar are: village and city water systems; sprinkler systems; railway water tanks; sewage disposal and purification systems, including sump and bilge pumps in buildings and areas below the surrounding drainage level; drinking water systems for hotels, apartments, office and factory buildings; hydraulic elevators; and coin and sidewalk lifts. Compressors and vacuum pumps are often used to operate some of the above as well as to furnish compressed air, or create a vacuum for almost innumerable purposes.

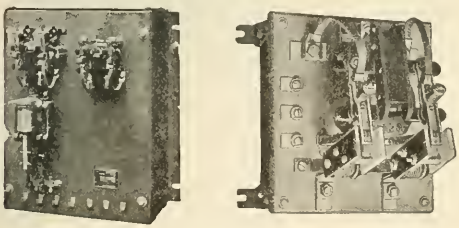
The Automatic Motor Starter

While hand operated starters and regulators are entirely satisfactory for some applications, the automatic motor starter has a number of advantageous features that make it particularly desirable for pump and compressor control. The remote



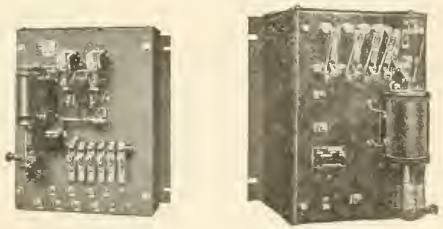
YEOMAN'S FORM A CENTRIFUGAL SEWAGE EJECTOR WITH TIME-LIMIT TYPE AUTOMATIC STARTERS MOUNTED ON TOP.

control feature enables an attendant to control the motor from any convenient point. All the operator has to do is to push the button, and the automatic starter brings the motor up to speed with promptness and safety. One or more push buttons or snap switches may be used, located wherever desired;



LEFT—ONE FORM OF TIME-LIMIT ACCELERATION-TYPE AUTOMATIC MOTOR STARTER FOR SINGLE AND POLY-PHASE INDUCTION MOTORS.

RIGHT—ACROSS-THE-LINE TYPE STARTER FOR SINGLE OR POLY-PHASE INDUCTION MOTORS.



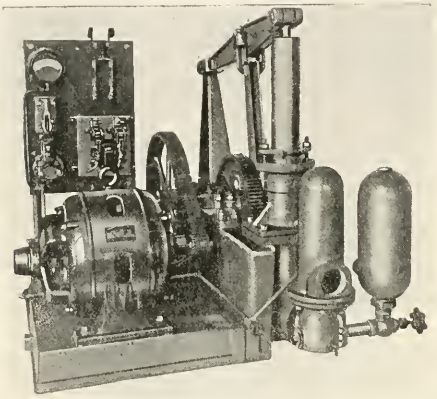
LEFT—TIME-LIMIT TYPE AUTOMATIC STARTER FOR A. C. SLIP-RING MOTORS.

RIGHT—A TYPICAL TIME-LIMIT SELF-STARTER FOR D. C. MOTOR.

or a float switch or pressure regulator may be used in place of the push button stations to provide complete automatic control. Automatic control permits the maintenance between fixed limits of the water level in a tank, or the maintenance between limits of water or air pressure in a compression system, or vacuum in a vacuum system, while the automatic operation of the starter itself accelerates the motor properly, irrespective of the skill of the attendant.

Adapting Controlling Apparatus to Size of Motor

The motor used may be for either direct or alternating current. If direct, it may be either series, shunt or compound wound. If alternating it may be one, two or three phase and of either the squirrel cage or wound motor types. If the motor is of small capacity and does not take excessive current when starting, a float switch, diaphragm type pressure or vacuum regulator may be used to connect the motor directly to the line. The float switches have larger current carrying capacity than the diaphram type pressure and vacuum regulators but float switches as a rule cannot be used to handle motor currents above 5 HP. It is evident therefore, that for larger motors some form of automatic starter must be used to handle the motor current. Where there is no objection to connecting the motor directly to the line a starter consisting of a double-pole magnetic operated switch may be used; however, when the motor is of larger capacity it becomes necessary to provide some means for reducing the starting current. This may be accomplished in several ways. The most common of which are: by inserting resistance between the mains and the motor terminals in the case of the single phase and squirrel cage type induction motors and by inserting resistance in the rotor circuit of slip ring type induction motors, or by inserting resistance in the armature circuit of direct current motors.



TYPICAL PUMPING EQUIPMENT FOR COUNTRY RESIDENCE SHOWING PUMP, 5-H. P. MOTOR, A. C. STARTER, DIAPHRAGM-TYPE PRESSURE REGULATOR AND PRESSURE GAUGE.

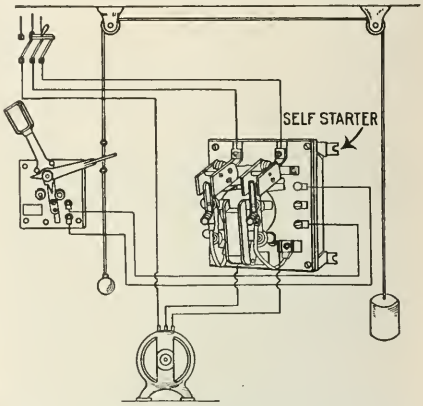
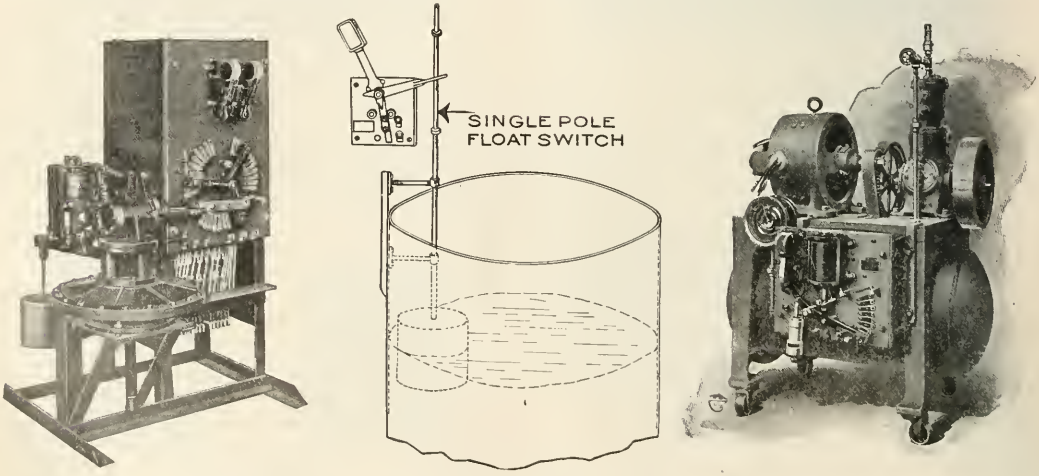


DIAGRAM SHOWING CONNECTIONS BETWEEN A. C. AUTOMATIC STARTER, FLOAT SWITCH AND THREE-PHASE INDUCTION MOTOR.

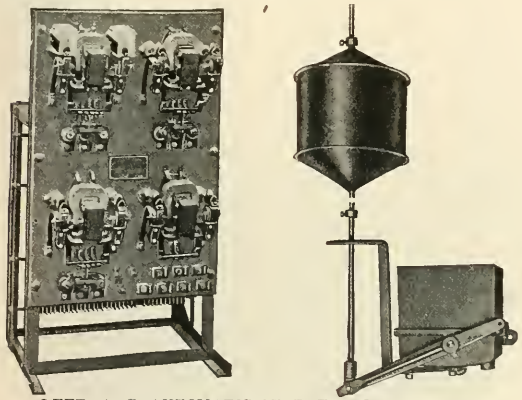
Two General Types of Automatic Starters

Two general types of automatic starters for limiting the starting current and providing proper acceleration are the time limit and the current limit types. With the time limit type the motor is brought up to speed in the same period of time at each start. The period of starting can, of course, be adjusted within given limits. Automatic starters designed for



LEFT—A PRESSURE-CONTROLLED SPEED REGULATOR FOR A. C. POLY-PHASE MOTORS. CENTER—ONE METHOD OF INSTALLING SUMP FLOAT AND FLOAT SWITCH. RIGHT—PORTABLE AIR COMPRESSOR WITH GAUGE-TYPE PRESSURE REGULATOR AND TIME-LIMIT TYPE SELF-STARTER.

current limit acceleration do not bring the motor up to speed in a given time, but the amount of current taken is limited. If the load started by the motor is heavy the motor is accelerated slowly, if the load is light, the motor is brought to speed quickly. In either case the current does not rise above a predetermined and adjustable amount.



LEFT—A. C. AUTOMATIC STARTER FOR SLIP-RING MOTOR, CURRENT-LIMIT TYPE.
RIGHT—ENCLOSED FLOAT SWITCH ARRANGED FOR WALL MOUNTING.

Speed Controllers

Aside from starting duty, controllers are also made for regulating or varying the speed of motors, the two general classes being the automatic and the hand operated.

Pump and Compressor Applications

For pump and compressor applications the automatic starter can be for either direct or alternating current, depending on the motor used, and can be of either the current limit or of time limit type depending on the type of pump and nature of the service. Typical forms of both types of starter for alternating and for direct current are shown in the accompanying illustrations. Any of the automatic starters shown can be controlled by a single pole knife or snap switch; by an open or enclosed float switch; by a diaphram or gauge type pressure or vacuum regulator or by a push button station having one normally open and normally closed button.

Float Switches

Float switches are made both open and enclosed. The open type are made with one or two poles and are generally used for tank and pump service where there is no danger of the contacts sticking, due to frozen moisture or an accumulation of dirt. The enclosed switches are made with one, two, three or four poles and although they cannot be submerged they are splash proof. Float switches are operated by the rising or sinking of a copper float as the water in the tank rises or falls. For tank service the switch is closed at low level and opened at high level. For sump service the arm is reversed, so that the switch is closed at high level and opened at low. The enclosed switches are made with various mounting arrangements—such as clamping over the edge of a tank—for inside wall of tank, and for outside of tank with the shaft extended to project through the tank wall. One style also has a floor pedestal and can be arranged to be operated either by the float and rod with upper and lower stops, or by float, chain and weight. Usually the single pole float switches are used in connection with a suitable self-starter. The two, three and four pole switches are used to control directly alternating current motors of less than one horse power.

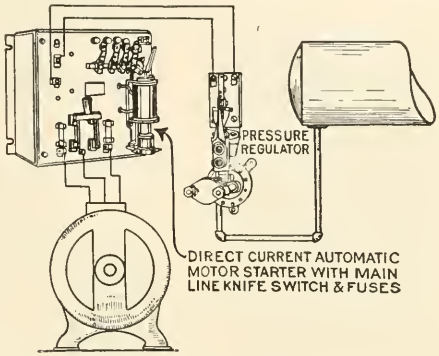
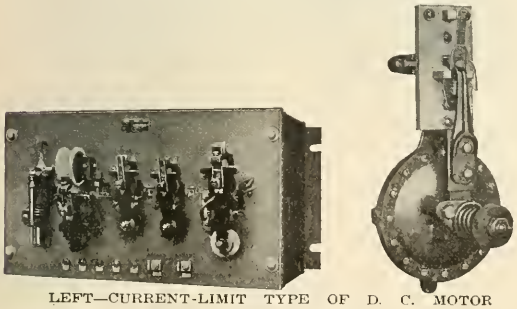


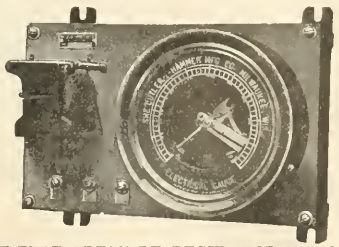
DIAGRAM SHOWING D. C. AUTOMATIC STARTER, PRESSURE REGULATOR AND MOTOR.

Diaphragm Type Pressure Regulators

Diaphragm type pressure regulators are used for pressures above atmospheric only. They are designed primarily to act as a pilot switch in connection with a motor self-starter. The single pole type may be used as a single pole switch for connecting across the line a small direct or single phase alternating current of a capacity not greater than ¼ HP. 110 volts. or ½ HP. 220 volts. The two pole regulators may be used to connect across the line direct current motors not larger than 1 HP. and two and three phase alternating current motors not larger than 3 HP. These regulators open the switch at high pressure, and close it at low. When it is required that the switch close at high pressure and open at low, a special regulator must be used. The diaphragm type regulators may be used on systems containing air, gas, water, or any other fluid which is not injurious to the rubber diaphragm. These regulators should be connected to an independent pipe from the tank, and not to the discharge pipe from the pump. This is to insure that it will not be affected by the fluctuation in pressure in the discharge pipe. If this is not possible, a small air tank or chamber should be installed between the discharge



LEFT—CURRENT-LIMIT TYPE OF D. C. MOTOR STARTER HAVING THREE MAGNETIC LOCK-OUT SWITCHES, MAIN SWITCH AND OVERLOAD RELAY.
RIGHT—DIAPHRAGM-TYPE VACUUM REGULATOR.

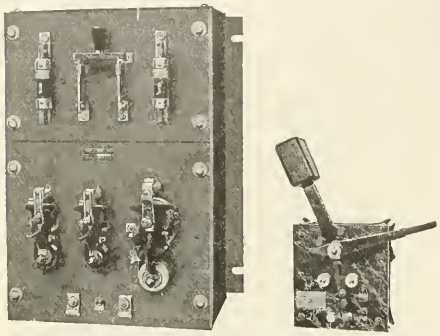


GAUGE-TYPE PRESSURE REGULATOR WITH MAGNETIC PILOT SWITCH.

pipe and the regulator to act as an air cushion. A stop-cock should also be provided to make it possible to throttle the supply pipe. Pressure regulators should always be mounted in a vertical position. Two wires are required to connect the regulator with the self-starter.

Diaphragm Type Vacuum Regulators

Diaphragm type vacuum regulators are for use on pressures below atmospheric only, and are designed primarily to act as a pilot switch in connection with a motor self-starter. They may be used, however, with small direct and alternating



LEFT—CURRENT-LIMIT TYPE OF D. C. MOTOR STARTER, HAVING THREE MAGNETIC LOCK-OUT SWITCHES, KNIFE SWITCH AND FUSES.
RIGHT—SINGLE-POLE OPEN FLOAT SWITCH.

current motors or not over ½ HP. to connect them directly to the line. Vacuum regulators usually open the switch at high vacuum and close it at low. Special vacuum regulators can be had to close at high vacuum and open at low.

Gauge Type Pressure Regulators

Gauge type pressure regulators are of the circular enclosed type and for use on pressure or vacuum systems. They are designed to handle solenoid currents only and must always be used in connection with a suitable self starter. It is often necessary to provide a relay in connection with the gauge to handle the starter solenoid current, the gauge carrying only

LEFT—SINGLE-POLE DIAPHRAGM-TYPE PRESSURE REGULATOR.
CENTER—DOUBLE-POLE OPEN FLOAT SWITCH.
RIGHT-DOUBLE-POLE DIAPHRAGM-TYPE PRESSURE REGULATOR.

the current required to operate the relay. On pressure systems the gauge should be connected to an independent pipe from the tank, and not to the discharge pipe from the pump, for the same reason given in the paragraph on diaphragm type pressure regulators.

Artesian Wells for Water Supply, with Special Reference to the Artesian Wells of Wisconsin

By W. G. Kirchoffer, Consulting Sanitary and Hydraulic Engineer, Madison, Wis.

The name artesian comes from the province of Artois in France, where wells of this character were first drilled and used extensively about the year 1800. Originally this was intended to apply only to those wells which flowed at the surface, but now it is quite generally understood to mean any and all deep wells in which the water rises above the formation from which the water flows. That is to say, supposing that in drilling a well several hundred feet of limestone or shale is penetrated and then a layer of sandstone is reached, if the well is artesian the water will rise from this layer of sandstone to a point comparatively near the surface of the ground. If it is not artesian, it will not rise above the surface of the sandstone. Thus we see that the only essential difference between a flowing and non-flowing well is that the surface of the ground, in the case of a flowing well, is below the level at which the water would rise from the water-bearing formation and that in the case of the non-flowing well the elevation of the ground at the site of the well is higher than the elevation to which the water will rise from the water-bearing formation.

Early Wisconsin Wells

The date of drilling the first artesian well in Wisconsin cannot conveniently be given, but according to a United States census private companies started water supply systems at Fond du Lac in 1840, at Prairie du Chien in 1876, and at Kenosha in 1880. At all of these places the water from the wells was under sufficient pressure to flow from the wells through the mains and into the house service pipes. The continued use of water in this way gradually reduced the pressure to such an extent that after a number of years it was impracticable to operate this system by this natural pressure. The system at De Pere, although not put in at such an early date as those mentioned above, has the distinction, however, of being the last city which was supplied with water in this way, as it was only in 1905 that the system was changed over to pumps and storage reservoirs.

In 1865 and 1866 wells were drilled at Palmyra and Oil City, Vernon county, with the idea of striking oil. The reason for making these borings was because there was a slightly oily substance discovered on the surface of the water flowing from a spring. Later this substance turned out to be a compound of iron. In 1875 a well was drilled at Prairie du Chien which had sufficient pressure to operate a water wheel which ran a mill. When the Mississippi river was at a high stage this water wheel was under water, but was always on the job. The old mill and water wheel are still in existence, but have not been used for a great many years.

The Essential Condition

The essential condition for the existence of artesian wells is a relatively porous stratum to receive and transmit the water lying between two strata that are relatively less porous, but not necessarily impervious. An inclined stratum of sandstone, with an up-turned edge lying between two layers of limestone or shale, furnishes this condition. The stratum must be inclined, or its edge turned up as an outcrop, to furnish an area for the collection of the water, and the outcrop must be at a greater elevation than the water-bearing stratum at the well, in order to supply the necessary pressure for a flow to take place through the stratum.

The conditions surrounding the existence of artesian wells could be compared very readily with a water works system in which we have an elevated tank or reservoir supplying the system of underground mains from which service pipes are run into the houses. The reservoir is comparable with the outcrop of the water-bearing formation, the system of underground pipes with the stratum of sandstone, sand or gravel which transmits the water, and the pipe leading to the house with the well. There is really nothing mysterious about an artesian well or spring, as some people have supposed. They are as simple as any problem in mechanics. There must be sufficient rainfall to soak into the stratum and to keep all of the pores well filled with water. Many other qualifying con-

ditions affect the quantity of the flow or the pressure, but they will not be discussed here.

There are in general two methods by which water finds its way through the strata: through the pore spaces of the rock and through fissures or between the lamina of the strata. The amount of water that can pass through the pore spaces in the majority of rocks is comparatively small. It is believed by the writer, from observations made upon the flow of water in Potsdam sandstone into a mining shaft, that the most of the water flowing through rock runs along the beds of the laminae or bedding planes of the rock, and that a comparatively small amount of water passes upward or downward through the rock unless it does so through fissures.

Sources of Artesian Water

In Wisconsin the main sources of artesian water are the Potsdam and the St. Peters sandstones. Some good flows are found in the Niagara limestone and occasionally in the Trenton limestone. The glacial drift also furnishes some small flows. The crystalline rocks and the shales are much too compact to transmit the water or have not the essential conditions for a flow.

The exact dividing line between the areas in which artesian water may be secured and that in which it cannot is difficult to define. In a general sense an artesian supply can be secured anywhere south of the general outcrop of the Potsdam sandstone.

A flow at the surface may be secured in most of the river valleys in this area, and especially is this true of the Mississippi, Wisconsin, Rock, Fox, Kickapoo and Baraboo river valleys and along the shores of Lake Michigan and Lake Superior.

From the data secured from a large number of wells it has been determined that the water will rise in most localities to an elevation of about 830 ft. above sea level or 250 ft. above Lake Michigan. It has also been determined that where the elevation of the ground considerably exceeds the above limit the water will stand at a higher elevation. This is probably due to the fact that there is little or no leakage from the water-bearing strata and that some additional water may percolate into the well from higher strata.

Along Lake Michigan and in the Mississippi valley, where the surface is much below the above limit of 830 ft., a reversal of conditions takes place, and it is found that the water will reach an elevation of about 700 ft. This is no doubt due to the greater leakage from the strata.

The clay rocks (shales, etc.) are too compact to be in any available degree water-bearing; they are the chief confining strata.

The crystalline rocks are much fissured at the surface and may afford additional collecting area for the outcrop of the overlying pervious sandstones. The beds of an open or porous nature are the only reliable sources for artesian wells; they are sand, gravel, sandstones and conglomerates.

Velocity of Flow

Although enormous quantities of water flow through these water-bearing sandstone and gravel beds and furnish supplies to many cities and private enterprises, yet the actual velocity through these formations is exceedingly slow. The ordinary velocity which one would expect to find in a sandstone formation would be from 1 ft. to 3 ft. per day, and in sand and gravel formations the velocity varies from this distance per day in fine material up to 100 ft. per day in very coarse material, as found by Professor Slichter in his under-flow investigations. It is very improbable that the velocity through the Potsdam sandstone in Wisconsin has a velocity as high as 100 ft. per day, but supposing that it did, we find that by making proper computations it would take at least 70 years for the water to flow from the collecting area to the Madison wells, and that, if the velocity was as low as 2 ft. per day, it would take about 500 years.

We have often heard it repeated in public meetings and elsewhere by those supposed to be familiar with this subject that the reason Madison is short of water in the winter time is because the pores in the rock near Lake Superior freeze up and the water cannot get through, but in the spring when the frost is out of the ground there is plenty of water. Even though the water did come from Lake Superior, which it does not, from the above statement one can readily see that a vast period of time would elapse before the water would reach Madison from that source, unless it came over-ground or was carried by railroad train. As a matter of fact, it is absolutely impossible for the water of Lake Superior or Lake Michigan to ever get into the artesian wells, because there is a great barrier of granite between Lake Superior and the southern end of the state and a thickness of 800 ft. of limestone between Lake Michigan and the central portion.

Artesian Waters Not Chemically Pure

While artesian and ground waters in general are usually pure from a sanitary standpoint, they are not pure from a chemical standpoint. That is to say, nearly all underground waters carry either in solution or suspension large quantities of mineral matter. These, of course, vary according to the character of the soil over which the water flows and the character of the underlying sand, gravel and rocks into which the water percolates. From a large number of analyses of waters it has been found that the effect of the drift, which was left by the glaciers, upon the mineral content of spring waters is not as marked as one might suppose. Out of 25 ordinary springs, of which 14 were known to flow from the drift and 2 from the rock, the latter contained only two minerals which the drift did not, viz., potassium chloride and sodium carbonate, and these were in very small quantities. Sodium chloride, calcium carbonate and silica were found in all of them. All other minerals present occur in about the same percentage of drift waters as of rock waters.

Mineral Content

The principal minerals which are found quite universally in both ground and artesian waters are the sulphates of sodium and calcium, the carbonates of sodium, magnesium, calcium and iron, and the chloride of sodium, together with alumina and silica. All sulphates, though occurring in small amounts, are more prominent in drift waters than in rock waters, whereas the carbonates occur as frequently in the rock as in drift waters, but the quantities of carbonates, especially those of magnesium and calcium, are found to be more uniform in the rock waters than in the drift.

From a careful study of some 70 analyses of ground and artesian waters it was found that the chlorine in 13 artesian waters from a depth of 800 to 1,350 ft. averaged 0.645 parts per 100,000; in 8 artesian waters, from a depth of 300 to 800 ft., the average was 0.657 parts per 100,000, while in 11 waters, from a depth of 100 to 300 ft., the average was 0.532 parts per 100,000. These figures, when compared with those for springs and shallow wells, will illustrate the foregoing statement regarding saline matters.

From such information as is at hand, it would appear that the mineralization of all artesian waters increases as the southern end of the state is approached and increases from the center of the state towards the east and west; or, in other words, the degree of mineralization follows the natural trend or dip of the rocks.

At Sheboygan, where the St. Peters sandstone is at the greatest depth below the sea level, we find the most highly mineralized water; also at Manitowoc, Sheboygan Falls and Milwaukee highly mineralized waters are found. At Prairie du Chien, on the western border of the state, where the bottom of the Potsdam sandstone has never been reached, we find a highly mineralized water.

Iron Content

The fact that iron is mined extensively in the northern

part of the state is sufficient evidence that it will be present in some water at least. Whenever water stands in or passes through formations containing iron, so long as free oxygen is present, the iron remains in a ferric condition and is entirely insoluble. The water drawn from such strata is free from iron, notwithstanding the fact that it has been in contact with large quantities of that substance. If, however, the supply of oxygen becomes exhausted in the ground, and the organic matters, often present in the soil or water, reduce some of the iron in the ground to the ferrous state (that is, some of the oxygen in combination with the iron is taken away by the organic matters), the iron in this reduced or ferrous state is quite soluble in water containing a little carbonic acid, and the water drawn from such strata contains iron in solution, usually as ferrous carbonate. It is thus seen that it is the conditions in the ground and water which cause the presence of iron in the water. These facts would seem to explain how it is that a water when first pumped is free from iron, but after a time iron is found to be present and in ever increasing amounts.

The above statement possibly may explain, at least to a certain extent, the reason why the water in the outskirts of some cities is not of as good quality as it was years ago, when the wells were not pumped to the extent that they are to-day. Various methods have been tried to remove this iron from the water, but few have ever been entirely successful. The most successful process, however, is that of aeration with a double contact of cope, and either mechanical or sand filtration. No doubt many waters would be greatly improved if they were subjected to a thorough aeration process as pumped from the wells by air lift pumps, and then allowed to settle in the reservoirs.

WATER PURIFICATION AND SEWAGE TREATMENT

Prevention of Imhoff Tank Foaming at Schenectady, N. Y.

By Harrison P. Eddy, of Metcalf & Eddy, Consulting Engineers, 14 Beacon St., Boston, Mass.

The foaming of Imhoff tanks has been a source of much embarassment to many operators of sewage treatment plants during the last few years. At Schenectady foaming was almost continuous in 1916, even in winter and spring when the temperature was very low. Last winter at Plainfield, New Jersey, also, the tanks continued to foam through the winter. As the foam escaped it froze and formed volcano-like mounds several feet in height, through the center of which a passageway was maintained for the escape of the continuous supply of foam. Nevertheless, foaming generally stops altogether, or continues at greatly reduced rate, during the period of low temperature.

Many plans for preventing foaming have been tried, and described in engineering literature. In some cases the foaming has ceased, temporarily at least, apparently because of the establishment of conditions favorable to digestion, but adverse to the phenomenon of foaming.

Conditions at Schenectady

The plant at Schenectady has been one of the most troublesome, because of the continuous and violent foaming. Experience at this plant was described by Earl Devendorf, then superintendent of the sewage treatment plant, in Engineering News-Record, April 4, 1918.

Schenectady has a population of about 100,000. When the Imhoff tank plant was built it was found necessary to curtail expenditures and construct but one-half of the tanks originally contemplated. In addition, foundation difficulties led to reducing their depth. As constructed, there are nine tanks having a maximum depth of 14.3 ft. and a free-board of about 0.8 ft. There is no means available for measuring the daily sewage discharge. It is estimated, however, to be from 8 to 10 million gallons, and it has been assumed that a population of about 65,000 is tributary to the plant. On this basis the gas and scum space above the slots is equivalent to 0.7 cu. ft. per capita.

Each tank is divided longitudinally into two sections and transversely into 16 hoppers, by concrete partition walls. Each hopper is provided with a gas vent about 2 ft. wide by 8 ft. long and has an 8-in. cast iron sludge pipe extending vertically to a tee about 5 ft. below the surface of the sewage, from which a side outlet pipe passes to an open sludge drain. The outlet of this pipe is closed by a gate valve. Above the tee is a short length of cast iron water pipe with the bell at the top. This bell is open and is about 6 ins. above the surface of the sewage as the tanks are normally operated.

Sewage Temperature

The municipal water supply is taken from large wells and is comparatively hard and of low temperature. During 1918 the average monthly temperature of the sewage has been as follows:

January	47.2°F.
February	46.4°F.
March	45.4°F.
April	42.4°F.
May	55.4°F.
June	55.1°F.
July	60.6°F.

The sewage is relatively fresh and much of the time contains a substantial quantity of dissolved oxygen. At night and early in the forenoon the sewage is noticeably diluted, undoubtedly due to much infiltration of ground water.

The freshness and relatively low temperature of the sewage during the early spring have in effect prolonged the season during which bacterial action is at low ebb and therefore have tended toward increasing the accumulation of undigested solids during this period of the year. Consequently, with the advent of warmer weather, bacterial action has been very violent.

Breaking Up Scum

There has always been a marked tendency for the suspended matter to rise to the surface and form a great mass of scum in the gas vents. Frequently it has been impossible to draw sludge, because the solids were almost entirely floating at the surface of the sludge compartments.

At times as many as five men have been continuously employed in breaking up the scum. Even when men were employed night and day, spraying the gas vents with water under high pressure, to drive down the scum and prevent foaming, some of the gas vents would foam over between the applications of water. This condition was much aggravated by the low freeboard, only a short period of time being required for the foam to rise sufficiently to overflow into the sedimentation compartments.

Corrective Measures Employed

To aid in controlling this condition the gas vents were raised about 12 ins., by means of wooden boxes. This provided a free-board of about 20 ins., the tops of the boxes being about 14 ins. above the bells of the sludge pipe risers.

Thus as the scum and foam rise in the boxes they can be drawn off through the sludge pipe risers. To facilitate this, a wooden plug attached to long handle, is pushed down below the tee in the sludge pipe, thus practically closing the lower portion of the pipe and preventing the escape of sludge. The scum and foam can then flow into the upper portion of the pipe and pass out through the side outlet into the sludge channel. When the scum is very thick and somewhat dry, it is necessary to break it up with a hoe or shovel and draw it to the riser. A small stream of water from a garden hose, discharged into the riser, facilitates the passage of thick scum through the pipe.

Controlling Foaming by Drawing Sludge or Scum

It has long been apparent at Schenectady, that foaming can be controlled by drawing sludge or scum. If the solid matter in the sludge compartments is entirely gas-lifted, it must be withdrawn, either in the form of scum from the top, or it must be driven down by means of hose streams and drawn in the form of sludge. In the latter case it is necessary to draw the sludge almost immediately after driving the scum to the bottom, otherwise the solids will be lifted again by entrained gas and the sludge will have disappeared.

Careful observations have been made by Mr. John V. Lewis, superintendent of the Sewage Treatment Plant, and by the writer, to ascertain if the drawing of scum is attended by the escape of more objectionable odors than the drawing of sludge. These observations have led to the conclusion that there is no noticeable difference, both appearing to be free from any odor other than the usual "tarry" smell.

Foaming Increased by Hosing Scum in Vents

Experience during the past year has led to the conclusion that foaming is encouraged by hosing the scum in the gas vents. This work has been carried to an extreme at Schenectady, because of the troublesome conditions which have existed. By it large quantities of clean water, containing dissolved oxygen, are introduced into the sludge compartments, which may favor the growth of organisms tending to produce carbon dioxide rather than those which produce methane. Accordingly, the use of water has been almost entirely given up during the past summer and foaming has practically ceased. Were it not for the fact that the sludge-drying bed area is too small, which has led to the postponement of drawing sludge and scum on some occasions, foaming could have been entirely controlled without the use of water.

Conclusions

As a result of the operation of this plant during the last three years, it appears that foaming can be entirely prevented or controlled by the drawing of well-digested sludge or scum, and that hosing encourages foaming and is useful merely in preventing the overflow of the foam in some cases where it is temporarily impracticable to draw the sludge or scum.

Some Design and Construction Features of the New Slow Sand Water Filtration Plant at Auburn, New York

By J. Walter Ackerman, Chief Engineer and Superintendent of Water Works, Auburn, N. Y.

In 1907 an epidemic of typhoid fever broke out in Moravia, and in the following year Auburn suffered an epidemic in the spring which cost the lives of 12 people out of 28 cases of typhoid. This started the agitation for a filtration plant and construction work was started on July 2, 1917. Due to unusually bad weather in the summer of 1917, when during the month of July there were 28 days of rain, the construction work was greatly hindered. Though hampered this year by labor conditions, the contractor has been able to make rapid progress, and it is expected the plant will be in full operation by July 1, 1919.

Slow Sand Process Adopted

After a thorough investigation slow sand filters were adopted, for the reason that the source of supply, Owasco Lake, is a large natural reservoir which is practically free from color and turbidity most of the time. The removal of pathogenic bacteria was the greatest problem and the slow sand process was adopted as the surest means of removing the bacteria, either when the raw water is clear or slightly turbid.

General Design

The general design is the usual one of concrete, with groined arch roofs, with all of the concrete in compression, so that no general reinforcing is necessary. The plant consists of four beds of about 0.4 acre each, and is so arranged that the raw water and the purified effluent pass through one combination regulator house, laboratory and sand washer, all under one roof. There is also a 3,000,000-gal. pure water reservoir to take up the fluctuation of the daily load in order to allow the filler to operate at a fixed rate.

Excavation and Embankment

No particularly novel methods were used in the construction of the plant. Excavations were largely made by steam shovel, of which there was a total of about 30,000 yds. A small fraction of the bottom of the filters is placed on rolled embankment in order to keep down the excavation to the necessary amount in order that the excavation would about balance up the fill around and on top of the filters. Rolled embankment was made also on the edges of the walls of the filters where the excavation was not deep enough to provide for solid earth to take up the roof thrust against the side walls.

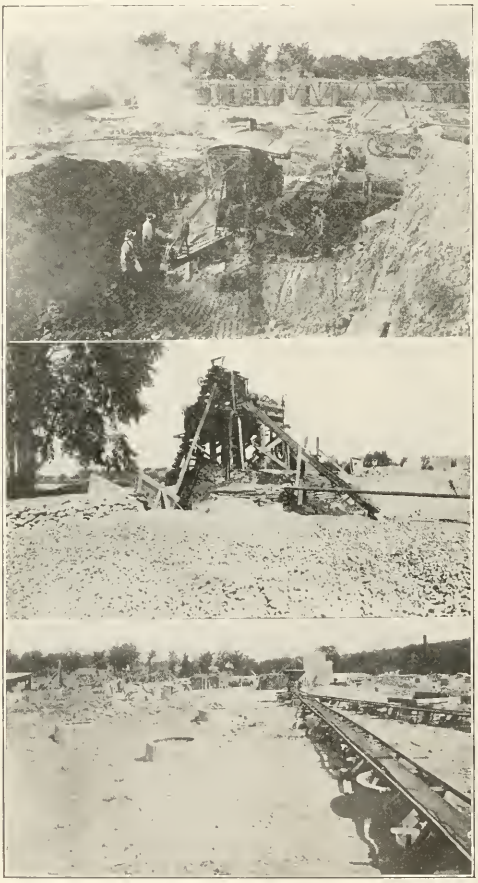
Strange to say, the greatest difficulty in the contract has been in the excavation. The tender for the contract stated that the excavation was hardpan, and subsequent evidence proved that this was no misnomer. Whenever any finishing had to be done by hand to secure an exact grade it was found that the workmen were almost unable to make any impression on the hardpan with ordinary picks, so that from the contracting standpoint the excavation was a losing venture. The contract, however, was let under a main contract as Contract "A" which included all of the excavation and the furnishing and placing of all concrete and completing all of the contracts. The material such as cast iron pipe, gates, valves and all appurtenances, was secured in separate contracts but was placed under the main contract, "A." Contract "A" was let to the J. E. Bunting Co., of Flushing, Long Island.

Concreting

The concrete was made, mostly, of local bank gravel after being screened in order that proper proportions of sand and gravel might be maintained. A self-filling batch mixer was used for the concrete with an automatic water control. The delivery of the concrete to place was accomplished by means of two-wheeled push carts that traveled on well constructed elevated run-ways which were high enough to pour all piers and side walls. The bottom slabs were generally poured by wheeling on the completed portions of the bottom already in place. The loading of the mixers was accomplished by means of a skip moving up an inclined track and operated by a steam winch, the steam being drawn from the same boiler that furnished steam for the mixers. This skip was arranged so that when the compartments were just filled with the gravel, sand and cement, the proportions were exactly correct.

The wall forms around the sides were made in sections 13

ft. in length with tapered keys on the end. The sections were built alternately, that is, a form would be set with sides and end bulk heads; this form would then be poured, and moved 26 ft. and again poured and then the intervening space of 12 ft. between the two complete sections would be filled by clamping the outside wall forms and pouring the space full of concrete. In order to hold the forms together bolts were used as difficulty was experienced in securing wires that were reliable enough to hold. When using the bolts they were greased and then wound with tarred paper so that after the concrete set up the bolts could readily be removed and the holes plugged and filled with cement.



VIEWS ON CONSTRUCTION OF AUBURN, N. Y., WATER FILTRATION PLANT.

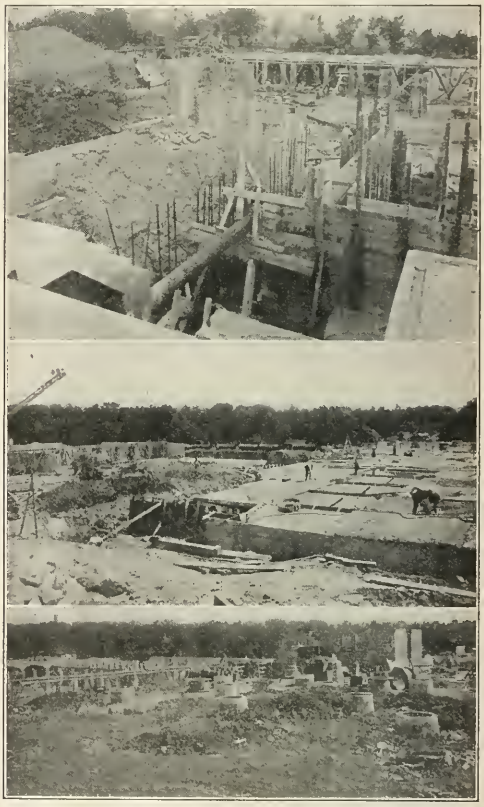
Keystone Steam Shovel Excavating for Filter Beds—Sand Screening and Washing Equipment—Industrial Track to Transport Filter Sand Over Top of Beds.

Locating and Concreting the Piers

The pier forms were of wood and so cut and mitered as to fit well around the piers and to form comparatively tight joints. By simply covering these joints with building paper they were made practically watertight. It was necessary to locate these pier forms very accurately and this was accomplished as follows: The point for each pier was determined by transit and tape, and the pier forms were so made that they can be taken down and reassembled. On setting a pier form on the floor of the filter, the intersection of two lines at right angles to each other was made to show the exact position of the center of the pier to be erected, and on the forms were also two lines. These bisected the center of the side of the form so they were placed exactly over the lines on the floor of the filter, then a plumb line was dropped from a template placed in the top of the form and the form then adjusted until the plumb was exactly over the center of the floor. The forms had to be weighted down to a considerable extent on account of the taper on the bottom and would lift if not so weighted.

Screening and Placing Filtering Material

Contract "B" was for screening and placing the filtering material in the beds and was awarded to the L. D. Sullivan Co., of Utica, N. Y. The sand contract has presented the usual



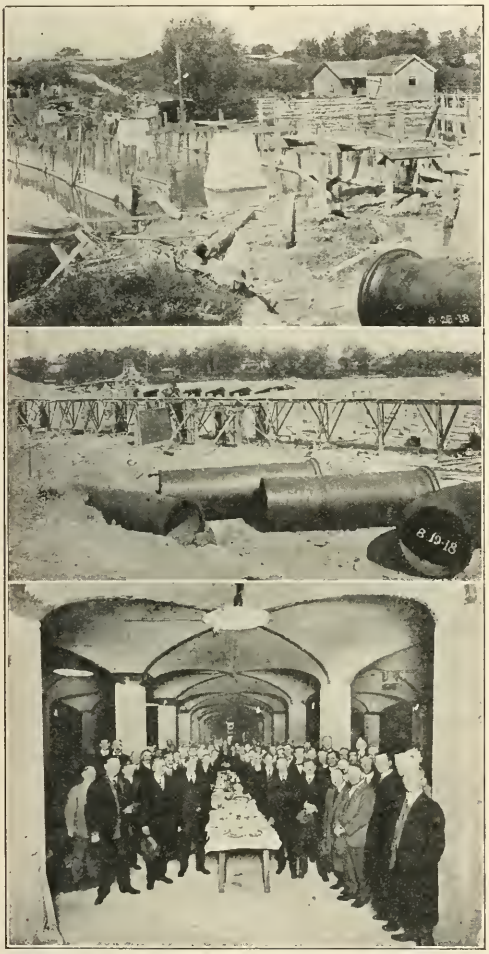
CONSTRUCTION VIEWS ON AUBURN, N. Y., FILTER PLANT.

Forms for Regulator House in Foreground; Concrete Mixer and Runway in Distance—Roof Forms—View of Part of Completed Filter Beds; Regulator House Partly Constructed in Middle Distance; Two Other Filters at Left Under Construction.

problems of screening and washing and while a very carefully worked out plan has been completed it was necessary to change it a number of times in order to get the results desired.

The screening apparatus consisted of rotary screens in which the first separation was the sand and gravel which would pass through the ⅜-in. mesh; the balance of the gravel

then went on and was again sorted into two sizes, one being all that would pass the 2½-in. mesh and be retained on the 1-in. mesh, and the other that which will pass the 1-in. mesh and be retained on the ⅜-in.; then the sand and fine gravel would next be sorted by a ⅛-in. mesh. This constituted the three grades of stone or gravel, the coarser one being placed around the under-drains of the filters and the two finer on top of that, and then the sand. The sand, after being screened, would drop into a washer box with sloping bottom containing



VIEWS OF NEW SLOW SAND FILTER AT AUBURN, N. Y.

River Crossing for 36 in. Raw Water Pipe; Cofferdam in Distance for One of the Piers—Concrete Runway; Cast Piers and Wall in Place; Roof Forms in Distance—Auburn Rotary Club Taking Lunch Inside Filter No. 1.

five 2½-in. pipes, and in which there was overflow troughs about 2½ ft. above the pipes.

The pipes were punctured with staggered ¼-in. diameter holes in the top and were supplied with water under pressure. This caused an upward current to pass through the sand, washing out organic matter, and the finer particles of sand were carried up and wasted out through the troughs. This was so adjusted to leave the effective size of the sand to be not less than 0.25-mm. nor more than 0.35-mm., and also so that the sand should not contain more than one per cent. finer than 0.13-mm. and the uniformity co-efficient should not be more than 3.0. To satisfy all of these conditions of the sand requires a lot of manipulation and the proper selection of the sand at the bank.

The bank from which the sand was obtained was one about a mile from the works. A Thew ⅝-yd. revolving steam shovel loaded the sand into the trucks and the trucks dumped the sand into the hopper from which an endless chain elevator carried it up and dumped it into the screen mentioned. The water for washing the sand was supplied by a 6-in. centrifugal pump, pumping about 400 ft. from the filter site. This pump delivered about 500 or 600 gals. per minute, and beside the pipes inside of the sand washing box there was some placed on top and by the side of the revolving screen to aid in the operation.

The Auburn water works is a municipally-owned plant, has a separate existence from the other city departments, and is governed by a commission of three men, one of whom is appointed each year. It has always attracted the best men of the town as it is considered an honor to be a Water Commissioner, and most all of the Commissioners have served a number of terms. For instance, at the present time two of the members are now serving their eleventh and twelfth years, respectively. This, of course, cannot help but create a continuity of effort which means a fulfillment of any definite and set program and explains why at the present time we are constructing a filter plant, even though the project was conceived and started more than eight years ago; but as it was conceived and started eight years ago the Board persisted in its predetermined effort and at last surmounted all obstacles and the work is well under way at the present time.

On the completion of one filter bed and before the sand was placed in it, the Rotary Club of the city of Auburn held one of its meetings inside of the filter. This was due to the fact that they were instrumental in conducting a propaganda in favor of water filtration, and took this way of celebrating the successful consummation of their plans. Mr. Allen Hazen, of the firm of Hazen, Whipple & Fuller, of New York City, was the consulting engineer.

Water-Borne Typhoid Outbreak Due to Neglect of Chlorinator

During May, of this year, a serious water-borne epidemic of typhoid fever occurred in California, where the water supply nominally was chlorinated. The occurrence of the epidemic shows how easily water chlorination may prove a disastrous failure if not carefully and competently supervised.

Merced Falls, where the epidemic occurred, is a small lumber town of about 350 inhabitants, located on the Merced River in the foothills of the Sierras. The entire town and its utilities are controlled by the Yosemite Lumber Co., which has extensive mills at this point. The town is located on high ground. Streets and buildings are clean and attractive. Complete sewerage, leading to a septic tank which empties into the river below town, has been in existence for a number of years. The water supply is pumped from the same river just above town.

Nominal Chlorination and Filtration

Following an epidemic a few years ago, a chlorinator and a pressure filter were installed. Filter alum is used, presumably, but the water is extremely soft and as coagulation is not provided, the filter is practically nothing more than a strainer. Entire dependence must be placed on the chlorinator for bacterial results.

The first chlorinator installed was an Electro-Bleaching Gas Company's machine, but corrosion became so serious that, in August, 1917, a Wallace & Tiernan solution-feed chlorinator was substituted, applying the disinfectant into the pump

suction, from which the water was pumped to a small elevated tank. Distribution is from the tank and off the pump force-main. The principal weakness in the installation appears to be that some of the water lines on which the machine depends for its pressure become affected with sawdust and the pressure becomes so low that the solution jar can not be kept full of water, causing the chemical to attack the cylinder jar head.

Onset of Epidemic

An April 15, Dr. D. I. Aller, company physician at Merced Falls, began to receive a few cases of diarrhea. The maximum number of cases occurred during the latter part of April or early in May. Between 50 and 75 per cent. of the residents of the town were affected by the diarrheal disturbance. On May 1st two cases of typhoid occurred. Subsequently, the incidence appears to have been as follows:

First week in May	6 cases (one death)
Second week in May	2 cases
Third week in May	4 cases
Last week in May	1 case (secondary)

Water Supply

On May 14, when the epidemic was about over, the State Board of Health was informed and Dr. Frank L. Kelly, acting director of the Bureau of Communicable Diseases, and Mr. Ray F. Goudey, Assistant Engineer in the Bureau of Sanitary Engineering, proceeded to Merced Falls. Investigation showed that on April 20 to 23, Dr. Aller began to suspect the presence of a water-borne epidemic of diarrhea. On investigating the chlorinator he found the solution jar head entirely corroded and the machine out of commission. He was unable to learn when the machine first began to give particular trouble or when it went out of commission entirely. He at once requisitioned a new head but this was not ordered until about May 1. It was installed about May 4 or 5, but the dosage was probably low until May 18. A dose of 1.1 lbs. per million gallons was in use on May 15. On May 18 the chlorine supply at the water chlorinator ran out and the cylinder of chlorine was taken off the sewage chlorinator and moved to the water chlorinator. Only 4 lbs. of chlorine were contained in it, however, and it was applied at the low rate of 1.5 lbs. per million gallons, in an effort to conserve the supply until a new cylinder could arrive on May 20. An emergency disinfection was arranged on the sewage by Mr. Goudey, consisting merely of two 50-gal. barrels in which a solution containing 5.25 lbs. of bleaching powder per barrel was made up and fed through an ordinary ¾-in. valve (the smallest valve obtainable) into the outlet of the septic tank. This arrangement was set up and operating within 30 minutes. A man was detailed to watch the working of the plant continuously until the new supply of chlorine arrived.

Merced River Watershed

Suspicion pointed so strongly to the water supply as responsible for the outbreak, that a sanitary survey of the watershed was made in order to locate the source of the typhoid and diarrhea contamination of the river, as the population on the watershed is relatively very small.

Above Merced Falls the Merced River has a watershed lying entirely in the Sierras, having an area of about 1,050 square miles. Close to its headwaters is the Yosemite Valley, 71 miles above Merced Falls. Two highways cross the watershed with Yosemite Valley as the objective. One railroad meanders up the river 54 miles above Merced Falls, with El Portal as its terminus. There is no highway along the river. The only industries of any importance are timbering in the vicinity of El Portal, mining in a small way at several points along the river, and the summer resort business in Yosemite Valley and at Wawona, the latter being on one of the tributaries of the Merced River. Not over 850 people live on the entire watershed and of this number 300 live at Coulterville, so situated that the possibility of stream pollution is remote. About 200 were living at Yosemite Valley, at the time, in resorts having good sewage disposal.

A sanitary inspection of most of the other places on the river was made in connection with this and previous investigations, the findings in three of these places being as follows:

Bagby, 24 miles. This place is quite a settlement, consisting of hotel, store, postoffice and saloon, about 50 people; water supply from springs in winter and from the river in summer. Sewers enter the river from hotel and store, other premises use privies, poor condition. Analyses indicate B. coli in 1 c.c. above and below Bagby.

Mountain King, 32 miles. This is also quite a settlement, about 60 people; water supply from springs in winter and from river in summer. Recent analyses of springs show gross contamination. Six sewers into river.

El Portal, 54 miles. Seventy people, 5 to 10 people use river water, others use springs. One septic tank, serving four houses, discharges into river, two privies in bad shape.

Sewage unquestionably enters the river at El Portal, Mountain King and Bagby. Elsewhere privies are in use and conditions such that there is little likelihood of pollution of the stream except in the rainy season. With the exception of the summer resorts at Yosemite and Wawona, the population is fairly permanent at this time of year. Water supplies are usually from springs at this season, though later in the year many of the settlements use river water direct.

Animal Pollution

Animal pollution is quite extensive at various points below El Portal. The B. coli content of the river water is higher than can be explained by the number of people sewering into the river and the dilution.

Rainfall

During the month of April there was a slight fall of rain, about April 20. The gauge at Merced registered 0.03 in. and the records show a slight fall of snow at Yosemite.

Stream Flow

According to daily gaugings at Merced Falls between March 15 and May 10, the maximum flow recorded on March 19 was 15,000 second-ft., decreasing to about 3,000 second-ft. on March 26, when it increased to about 7,500 second-ft., dropping gradually to about 3,000 second-ft. on April 11, when it rose to 4,000 second-ft. on the 13th, slightly increasing again on the 20th to about 6,000 second-ft. at which flow the river remained quite consistently to May 10.

Analyses at Merced Falls

The following analyses of the raw river water are on file in this office:

January 22, 1918	0.5 B. coli per c.c.
March 21, 1918	0.1 B. coli per c.c.
May 16, 1918	0.1 B. coli per c.c.

These analyses do not indicate what would be termed a gross contamination of the river. They are approximately what would be expected from a watershed having the sanitary conditions as found by the sanitary survey here reported.

The foregoing data and discussion are from an article in the Bulletin of the California State Board of Health for July, 1918, by C. G. Gillespie, Director, Bureau of Sanitary Engineering, and Dr. Frank L. Kelly. Their conclusions follow:

Conclusions

All the evidence points clearly to this epidemic as typically water-borne. There is no suspicion that it could have been due to the ingestion of contaminated milk or food or to unsanitary surroundings.

The outstanding features of this epidemic are:

1. The sparse population on the watershed, about 0.8 per square mile.

2. The high dilution by the river of the sewage of people contributing directly at the time of the epidemic, probably 40 million gals. of river flow per person actually tributary.

3. The low B. coli content in the raw river water at Merced Falls, probably not over 0.5 per c.c. at the time of the infection.

4. The failure of chlorination at the very time when it was needed as the sole line of defense against infection. The investigation revealed that no one responsible for the chlorination felt the weight of his responsibility. Time and again the State Board of Health has urged, directed and ordered greater vigilance.

The facts as gathered show simply that poor operation and the lack of interest finally culminated in a corroded solution jar head about 10 days, and possibly more, prior to the appearance of the epidemic; that nothing was installed as an emergency, and considerable delay elapsed after the order for the part was placed with the manufacturer of the machine.

The company now agrees to appoint a full-time operator in charge of sanitary equipment in order to make every improvement conducive to continuous chlorination, including the better gauging of the flow of water, the frequent reading of the chlorinator, the weighing of the chlorine used and on hand, the keeping of a weekly report of operation, and the periodic sampling of the raw and treated water.

The Merced River is perhaps as innocent appearing a stream as any in the state, not excepting the multitude of creeks which now furnish water to the bulk of the Coast Range cities and towns. At this time of year its flow is tremendous, yet its sources and pollution can almost be counted on the fingers. The experience at Merced Falls illustrates and proves the contention that, at least in the present age, vigilance is the price of freedom from typhoid.

Bridges and Buildings

Low-Water Highway Bridges in Oklahoma

By J. W. Evans, Assistant Engineer, Oklahoma State Department of Highways, Oklahoma City, Okla.

A difficult problem in bridge building in Oklahoma has been partially solved by the use of low water bridges. Many of the western streams in the plains region flow through wide flats and have shifting channels with low banks in beds of sand. They carry little or no water except at times of sudden and infrequent floods of short duration. To bridge such a stream with a truss or high concrete bridge would be expensive, but would prove satisfactory if one could be reasonably sure that the river would continue to flow under the bridge. At flood time the stream usually spreads over the river bottom to such an extent that no kind of bridge would be accessible.

The expense of lengthening a high truss when the stream washes around the end of it, or when the stream chooses a new channel half a mile from the bridge, has led to the building of the cheapest possible types. Attention has been turned to low water bridges, and cheapness of construction has been thereby attained. Flood water passes over such structures and renders them impassable during the duration of the flood, which time amounts to not more than five days during the year.

Concrete Flat Slab Construction Adopted

Many failures have occurred with low water bridges, and both theory and experience have led to the use of a concrete flat slab supported by a light pier on wood piling. The standard used in this state is built in panel lengths of 20 ft., with expansion joints at alternate piers and five piles under each pier. Piling is driven to solid footing and is cut off below low water. There is no curb but provision is made for a cable railing supported on posts. Form work is handled at minimum cost since framing is often eliminated by supporting the slab forms of lumber or heavy paper directly on the sand.

Wood Construction Unsatisfactory

In rivers where the flood carries large amounts of draft, it is necessary to place the bridge sufficiently low so that the flood water will not only pass over, but will carry the drift above danger of lodging on the bridge. Wood construction has in general proven unsatisfactory on account of the difficulty of holding the floors, and practically all new work is of concrete. Several concrete bridges have been built from 100 to 400 ft. long, and there is now under construction a bridge 1,200 ft. long of this type.

As shown in the accompanying pictures, one of these concrete bridges was recently pushed slightly out of alignment by the drift which lodged against it during an unprecedented flood. The cause of this can be traced to the fact that the bridge is built too high. In this case not more than a foot of space should have been left between low water and the bottom of the slab. This occurrence demonstrates that flood conditions should be observed in each stream prior to construction in order that the drift carrying stage may be determined.

Concrete Low Water Bridges Are Satisfactory

The current at flood time in the streams is very swift, and as a result the sand in the stream bed is set in motion to a depth of 10 ft. or more. It is evident from this that the bridge itself which is at times covered with 8 or 10 ft. of water

LOW WATER BRIDGES ON OKLAHOMA HIGHWAYS.
Left: Upstream View of Concrete Low-Water Bridge after a Flood. Center: Downstream View of Same Bridge. Right: Wooden Floor and I-Beam Joists Were Carried Away by High Water.

must be heavy, firmly anchored, and must offer little surface to the force of the stream. Experience in this state has proven that the concrete low water bridge, properly located and built, can be depended upon during practically the entire year.

Recommended Practice in Design and Construction of Permanent Highway Bridges of Concrete and Steel

By John W. Towle, Government Representative, Emergency Fleet Corporation, Philadelphia, Pa.

Today there are but two generally accepted types of bridges that are suitable for permanent highways, and these are constructed of concrete and of steel.

The decision as to which of these two is best adapted to a given location is at times difficult to make, and is largely a matter of judgment. In a general way, however, the shorter spans should be built of concrete and the longer ones of steel, leaving the lengths between 24 and 60 ft. to be determined by individual conditions, said Mr. Towle, in addressing the North Carolina Good Roads Association.

Concrete Bridges

There are three general types of concrete superstructure:

1. The flat slab or box culverts, for short spans.
2. The girder, having two or more heavy stringers, running lengthwise for the middle lengths.
3. The circular or elliptical arch, for the longer bridges.

Flat Slab Construction

1. The first type consists of a flat slab of concrete, extending the full width of the bridge or culvert; having a thickness usually from 6 to 12 ins., depending upon the distance the supports are apart. Running parallel with the roadway and stretching from foundation to foundation, is a series of reinforcement bars ½ to 1-in. thick, usually 6 ins. on centers, and placed about 2 ins. from the bottom of the slab. These are supplemented with other reinforcing bars of smaller sizes at right angles, thus making a network of steel to tie the concrete together and to give the tensile strength necessary to carry the loads. The slab construction is rarely used in bridges over 16 ft. in length.

Girder Bridges

2. The girder concrete spans usually have from two to four stringers running lengthwise of bridge. Each girder has a width of from 10 to 14 ins., and a depth of from 12 to 36 ins., depending upon the length of the span, number of stringers, and capacity for which the bridge is designed. For the floor system a slab of concrete covers the entire bridge, resting over the stringers. The girders must be strongly reinforced near the under side with heavy steel rods from ¾ to 1½ ins. in size and in numbers sufficient to give the necessary tensile strength. This style of span can successfully be constructed up to lengths of 40 ft.

Arch Bridges

3. The arch is the natural type for concrete bridges, and is a modern development of the old-time arch that has been used for many centuries. By the proper use of reinforcing steel the quantity of material necessary can be greatly reduced, and a greater safety insured. It is desirable to have arches designed as nearly a half circle or a half ellipse as the height of the bridge will permit.

The arches are either solid or uniform, having a varying thickness at the center of 10 to 12 inches, and at the ends of about 14 to 18 ins., depending upon the length of the span, rise of arch, and strength desired. In many cases the arches consist of individual and separated girders, connected together over the top with a thin floor slab. At the sides of the bridge and above the arch are the spandrel walls, which hold the fill and pavement in place and form the base for the hand rail.

This style for the ordinary highway bridge usually runs from 40 to 60 ft., and in exceptional cases has been built up to 200 ft. in clear span. One arch over the Spokane River in Spokane, Washington, has a length of 350 ft.

One of the great advantages of the concrete bridge is that it has more or less fill over the span and permits of a continuous roadway pavement.

Bridge Foundations

As in all engineering structures, the foundation is of the most vital importance. The slightest settlement in a concrete span spells disaster. I have in mind one long bridge over the Illinois River at Peoria, where a settlement occurred in one pier; it caused a failure of an adjoining span; the pier being relieved of the balancing end-thrust was pushed out of line, causing the failure of the next span; and so on, one at a time, they fell into the river, making the complete destruction of a million-dollar structure.

A thorough test of the underlying strata must be made before an intelligent opinion can be formed as to the foundation necessary. A bed of gravel, a layer of hard, dry clay, or a stratum of shale or rock, will usually suffice. This can be easily reached, if below water, with the aid of a cofferdam built of boards or plank properly lapped. After the bed is thoroughly cleaned of all loose and soft material, the footings of concrete are poured.

Should the desired location for the bridge bring the supports where there are no solid strata, then it becomes necessary to make an artificial foundation, and this is most commonly done by driving wooden, concrete, or steel piling. The length and number are determined by driving tests and computing with engineering formulas, having as known quantities the weight in tons of the structure itself, and the desired capacity for which it has been designed.

In some of the longer spans, where special cases seem to demand them, steel tubes from 6 to 12 ft. in diameter are sunk to a firm foundation and filled with piling and concrete.

Wings and Spandrel Walls

Next in importance to the foundations and the superstructures of concrete bridges are the wings and spandrel walls. When properly designed and constructed, they retain the fill over the span and in the approaches, making it possible to have a solid roadway of full width, up to and over the entire structure. The place of greatest danger about a bridge is always at the approach, and this gives us a further reason why these parts should have special attention.

Upon the top of the spandrel walls is built the railing. This can be of varying form and material to suit the artistic demands of the community.

Concrete Mixtures

The mixtures for the different parts of the bridge can be varied somewhat, if you take into consideration only the strength desired. It is the best practice, however, when by the addition of a small amount of cement a more permanent and lasting concrete can be made, to add it. It is false economy not to go to this small extra expense in outside concrete work.

The superstructures, the slab, the girders and the arch, take the greater strains, and should have perhaps the richest mixtures; the standard being for them, 1 part cement, 2 parts sand, and 4 parts stone or washed gravel. The wings and spandrel walls, acting as they do more as retaining walls, should have a mixture not weaker than 1, 2½ and 4½. The mass concrete in the foundations, where even less strength is required, can have the proportions of 1, 3 and 5.

Quite often when streams are shallow and their banks low, and the roadway but a few feet above the surounding land, it becomes quite a problem to get the necessary waterway. The arch type must have a considerable rise in order to attain full strength. The girder presents less of a side wall

to the floods and is often substituted for it, even beyond its economic length. So it frequently becomes necessary to give up entirely the idea of a concrete span for a steel design because of the lessened bulk and the corresponding reduced obstructions to the flow of water.

Steel Highway Bridges

We have but two types of highway steel spans in common use—those utilizing the Pratt truss and the Warren truss. The Pratt truss is perhaps the simplest, the most economical and the most satisfactory for highway purposes of any that has ever been developed. It has straight horizontal top and lower chords, the former in compression and the latter in tension, with intermediate posts in compression and hangers and long diagonal members in tension. These bridges can have either a low truss or a high truss, the latter having an overhead system of braces above the roadway. In length the low trusses are usually from 24 to 100-ft. and the high trusses from 80 to 400-ft.

This type of span can have many variations, such as the half-hip for short spans; thus the inclined top chord, the double intersection, the subdivided panel for the long spans. There can be either deck or through trusses, and both pin-connected and riveted bridges. In fact, having such simple lines, so easy of computation and analysis, and so economical in its design, it stands out today as the one type of bridge most satisfactory to the engineer.

The Warren truss is used quite commonly in rivet-connected spans of shorter lengths; but principally in low trusses; rarely in bridges over 80 feet in length. A few high trusses have been constructed of the Warren type, but on account of the long diagonal members being in compression, it makes an unsatisfactory design, and is contrary to the best engineering practice.

Difficult locations involving complicated erection problems often require special designs: for instance, in places where it is impossible safely to erect false work it is quite common to select an arch or cantilever truss which can be erected by balancing each increment of steel until it closes in the center and becomes a continuous and a complete structure.

Foundations

The best foundations for steel bridges are concrete with the seats for the shoes reinforced. The piers or abutments should rest on solid strata the same as in the concrete bridge, or else piling should be driven to a firm and substantial footing. Quite frequently steel tubes 3 to 6 ft. in diameter are settled into place, never less than 6 ft. below any possible wash, with piles driven through the bottom deep into the river-bed. Concrete is then poured about the head of the piles and the tube completely filled. Each shoe of the truss sets on one tube, thus making a very satisfactory support.

Floor Systems

For hard surface roads and well traveled highways, nothing but substantial and permanent floors should be constructed. Either concrete floor slabs, spanning from beam to beam, should be used, or else steel joist, with a concrete covering. This concrete should be strongly reinforced and made in the most careful manner of not less than a 1, 2, and 4 mixture. These floors should be so joined to the abutments as to provide a perfectly smooth connection with the roadway at each end of the bridge; as in concrete spans the wings and approaches are of great importance, for they serve to maintain a safe and satisfactory roadway up to and over the structure.

Rules to Observe in Bridge Building and Maintenance

1. Be sure and build the foundations high enough, so that the floor system of the bridge will be above any known high water.

2. Always carry the foundations at least 6 ft. below any future wash in the bed of the river.

3. See that the design of the wings and backing at the end of the bridge is such as to maintain a permanent approach fill.

4. The steel of the spans should be thoroughly scraped with steel brushes, and painted at least once in every three years.

5. Cracks due to settlement or expansion in concrete structures, should be carefully repaired once every year.

6. In deciding upon the kind and length of a new bridge for a given location be sure to compute carefully from the area of the watershed the flood waters that must pass under the structure.

7. Never build a bridge with less than 16 ft. of roadway, and it would be much better to make it 18 or 20 ft. so as to have sufficient width for the passing of vehicles.

Conclusion

The nation's highway system is the foundation of its whole vast and complicated machinery of transportation. The public highways are indispensable, and they should be kept in condition. Money must be spent and labor and material must be used *now*. In many of the Eastern States the army truck has partially destroyed the highways; so the maintenance should go on uninterruptedly or the tax-payers of the country will have to pay an enormous bill for their restoration after the war. Their present value in terms of service rendered is literally incalculable, for without them every activity would have to cease.

Prove That You Are a 100 Per Cent American

Today it is an honor to say: "I am an American." When you see a boy in the U. S. khaki, or a blue-jacket from our Navy, it makes you proud to say, "I am an American." When you read of the heroic acts of our boys on the fighting front it makes you thrill when you think, "I am an American."

You have the right to say that if you are doing your share; if you are obeying cheerfully the laws and regulations made necessary by the war; if you are learning to speak the language of America, or helping others to learn it; if you are a citizen or preparing to become a citizen of America; if you are backing the Liberty Loan with every dollar you can possibly invest—then you have the right to say with pride, "I am an American."

Buy Liberty Bonds.

A Motor Operated Masonry Surface Rubbing Machine

To meet the demand for a speedy machine with a good range of action for rubbing and polishing side walls, columns, bridges, subways, etc., the Cavicchi Polishing Machinery Co., of Quincy, Mass., has developed a portable motor operated machine equal to ten manual workers, it is claimed.

The rubbing wheel is on a jointed arm and has a radius of action of 6½ ft. vertically from the floor and 8 ft. horizontally. The rubbing wheel and the water pump to eliminate dust, are driven by a motor made by the General Electric Company.

Springs in the arm, counteract its weight and keep the carborundum wheels of the various kinds suitable for the different classes of work pressed against the wall regardless of its irregularity. An ample supply of water is provided by a reservoir in the body of the machine.

Refuse Collection and Disposal

Effect of War Conditions Upon Production and Disposal of Municipal Refuse

By Rudolph Hering, D. Sc., Consulting Engineer, 170 Broadway, New York, N. Y.

The war conditions in this country have had quite a number of noticeable effects upon many of our engineering activities, among which is the effect upon the production and disposal of municipal refuse. The general effort which we are all making to economize in our food and urging its most complete utilization, the frequent signs, "Food Will Win the War—Don't Waste It!" have had a substantial result in the decrease of the usual quantities of garbage in many of our cities. Also such rubbish as waste paper and leather have here and there decreased, and the shortage and greater cost of coal may also reduce the usual amount of ashes. These results are of interest and value in several directions.

American Extravagance

They emphasize most prominently our American extravagance. Every European country has had less municipal waste than we have, as comparative figures in the per capita production, particularly of garbage and rubbish, indicate. In European cities there has nowhere been enough grease left in the garbage to pay for its special extraction, while here most of the large cities have made its extraction a profitable business. In Europe the picking over of the rubbish had been almost everywhere condemned and abandoned some half dozen years ago, while here despite our higher wages, picking over is still practiced in some cities.

Will not our natural evolution gradually increase our economical sense to the standard of Europe? Will not perhaps the present enforced effort of greater economy open the way to it? There is, I believe, every indication that we, as a nation, will be less extravagant in the next generation than we have been in the past. Our enormous war debt must be paid. Our labor cost will no doubt remain higher than that in Europe, making world competition in manufactured articles no less difficult than heretofore, realizing that labor-saving machinery will be as common in Europe as it will be here.

Need for Greater Economy in Wants and Greater Skill in Production Methods

To reduce the inevitable effect of these prospects, there seem to be two solutions. One is the exercise of greater economy in our daily wants, approaching the European basis, and the other is the exercise of greater skill in our production methods. They will have to be obtained by a more thorough education and better training, so as to make the net result and useful return from a day's work go further than heretofore.

Will not then also the diminution of waste naturally be one of the first points to attack? Consequently we shall endeavor to utilize whatever can be profitably saved at our homes. We shall ascertain the greatest value inherent in whatever we personally no longer require and endeavor to realize such value elsewhere.

Garbage Utilization

Let us take garbage as an example. It is produced by the rejection of those parts of our food materials which are undesirable or unfit for us to eat. This garbage today when it is fresh has its greatest value for hog feeding. When it is partly decomposed it has a lesser value, derived only from the grease that can be extracted from it and the fibrous residue which can be used as a filler for high-grade fertilizer or as a fuel.

Therefore, we should first try to recover its greatest value and collect garbage daily and use it fresh as animal food, wherever conditions allow this to be done. We must adopt the best practicable methods for prompt collection in clean wagons or trucks and have well designed, clean and easily accessible feeding places.

Feeding the Preferred Solution

Under favorable conditions feeding will unquestionably be the preferred solution for most of our cities in the future on both economical and sanitary grounds.

Where feeding is not practicable, then, for instance, in large cities, excepting hotels and eating houses where feeding may remain most profitable, works for grease extraction may remain as the next profitable means of utilization. When our citizens become as economical as those in Europe and reject only a very small amount of grease, then either burial, as in Berlin, or incineration, as in England, would be in order.

We have already had difficulty at reduction works with tin cans and corn cobs. They yield no grease and cause a lot of trouble. It is, therefore, suggested that cans and husks be picked out and separately treated. Water melon rinds may come next.

Regarding the rubbish in war time, it is questionable whether the higher prices obtained from reclaimable materials will on an average pay for the higher war-time wages. Even if it would pay it is questionable whether the medical profession will not eventually find a serious objection to picking over rubbish, some of which might include rejected beds, clothing, rags and sweepings from sick rooms.

Garbage Utilization Work of the United States Food Administration

By F. C. Bammar, Garbage Utilization Division, U. S. Food Administration, Washington, D. C.

The United States Food Administration is undertaking investigations in the larger cities utilizing their garbage to determine three main points:

1. The amount of edible food finding its way into the garbage pail.
2. The extent and nature of foreign materials being placed with the garbage and interfering with its utilization.
3. The extent to which garbage is burned or otherwise destroyed.

In each instance corrective measures are also being developed and the educational campaign is being intensified. Of course cities not utilizing are being urged to undertake utilization methods and every possible assistance is being offered such cities.

The educational campaign mentioned contemplates the use of garbage as hog feed or through reduction plants. The fundamental object of the campaign is to persuade the housewife to keep her table and kitchen refuse free from tin cans, bottles, broken crockery and other foreign materials and to see that it is utilized after it leaves her door.

Data on Garbage Utilization

One Ton Garbage Will Produce:

1. Sufficient glycerine for the powder charge, as nitroglycerine, of 14 75mm. shells.

2. Sufficient "fatty acid" for the manufacture of 100 12-ounce cakes of soap.

3. Sufficient fertilizing elements to replace the nitrogen, potash, etc., taken from the soil by the growing of eight bushels of wheat.

Value Recovered from Garbage in 29 Largest Cities

Twenty-nine of our larger cities are disposing of their garbage by the reduction process. Their combined population exceeds 18,000,000. From the garbage of these cities is obtained the following:

Estimated grease production.....72,000,000 lbs.
This amount of grease will produce 10,000,000 lbs. of nitro-glycerine, enough for the powder charge of about 16,000,000 of the French 75mm. shells. The fatty acids contained are sufficient for the manufacture of about 200,000,000 12 oz. cakes of soap.

Estimated fertilizer tankage production.....150,000 tons
This amount of tankage contains about 9,000,000 lbs. of nitrogen, 2,000,000 lbs. of potash, enough to replace the nitrogen and other elements taken from the soil by 8,000,000 bushels of wheat.

Estimated value on June 15, 1918, of the above amounts of grease and fertilizer tankage.....$11,100,000

Utilized Garbage Values in Some Cities

In practically all of the above cities large amounts of garbage are destroyed by burning or made useless by being mixed with other wastes. The total amount of such unutilized garbage is estimated as sufficient to produce the following:

Estimated grease wasted.....9,000,000 lbs.
This amount of grease will produce about 1,300,000 lbs. of nitro-glycerine, enough for the powder charge of about 2,000,000 75mm. shells; fatty acids sufficient for the manufacture of about 25,000,000 12 oz. cakes of soap.

Estimated fertilizer tankage wasted.....22,500 tons
This amount of fertilizer tankage contains about 1,250,000 lbs. of nitrogen, 3,500,000 lbs. of phosphate of lime and 350,000 lbs. of potash, enough for the replacement of the elements removed from the soil by 1,000,000 bushels of wheat.

Twenty-four Large Cities Not Utilizing Garbage

Twenty-four cities of over 100,000 population are not utilizing their garbage. Their combined population exceeds 5,000,000. This means that the following is lost:

Grease, estimated at.....30,000,000 lbs.
This amount of grease would produce 4,400,000 pounds of nitro-glycerine and 40,000,000 12 ounce cakes of soap.

Fertilizer tankage estimated at.....60,000 tons
This amount of tankage contains fertilizer elements sufficient to grow a 3,000,000 bushel crop of wheat.

Estimated value on June 15, 1918, of the above amount of grease and tankage.....$5,000,000

Pork Production from Garbage

One Ton Garbage Will Produce:

100 lbs. of good, firm white pork.

Three hundred of our cities of over 10,000 population are disposing of their garbage by feeding to hogs. Their combined population exceeds 9,000,000. Their garbage would yield the following:

Estimated pork production.....100,000,000 lbs.
Because of poor separation, inedible materials in garbage, losses, etc., the amount of garbage fed pork actually marketed each year is about 50,000,000 lbs. This would have a value of over $8,000,000.

Group of 350 Cities Not Utilizing Garbage

Over 350 of our cities between 10,000 and 100,000 population are not utilizing their garbage. Their combined population exceeds 6,000,000. The utilization of their garbage would yield the following:

Estimated pork production.....60,000,000 lbs.
Probably the feeding of the garbage produced by these cities would only add from 30,000,000 to 40,000,000 lbs. of pork, valued at about $5,000,000.

Pavement Cleaning and Maintenance

Preservative Effects of Macadam Surface Treatments Applied Primarily as Dust Layers

By F. S. Krug, Chief Engineer, Engineering Department, City of Cincinnati, Ohio

The oiling of streets in Cincinnati was considered at first as primarily a dust laying measure, and was advocated as a method superior to sprinkling, both on account of its comparatively permanent results and on account of the destructive action of the constant wetting of a macadam road surface, and it was not until streets had been oiled or treated during successive years that its value as a preservative became apparent.

Large Mileage of Macadam

The city of Cincinnati has a very large mileage of macadam (approximately 281 miles) out of a total of 576 miles of improved streets, based on a uniform width of 30 ft., and a very large proportion of these macadam streets has been treated with oil or some other preservative.

It seems needless to go into the merits of these surface treatments as dust layers, as there is no question of their efficiency for that purpose, and their superiority over the old method of constant wetting is so marked, and the destructive action of water on a macadam surface is so well known, that it is doubtful if sprinkling of a macadam surface should be permitted.

We come then to the other action or result of oiling, namely, its preservative action, and this cannot be treated separately from the other preservatives, such as tar products and liquid asphalt, each of which seems to have its particular qualities and merits.

The proper consistencies of tar and asphalt products for surface treatments are quite well known, but this is not true of road oil. There are many grades of oil in use, all of which are (to a more or less extent) dust layers, but I believe it inadvisable to use anything less than a 50% asphaltic content oil, and I prefer a 60% unless the street surface is subjected to light traffic and has had several annual treatments, in which case a 50% oil might be used to advantage.

In the annual report of the Division of Street and Sewer Repair for the year 1917, submitted to me by Mr. C. L. Harrison, Engineer in Charge, Mr. Harrison writes as follows:

The Preservative Effects of Surface Treatments Applied Primarily as Dust Layers

The macadam street area which is annually treated with oil, tar or asphalt products for the purpose of dust laying has shown a marked increase during the last few years, and the effect of these treatments as preservatives

(aside from their primary purpose of dust laying) is becoming more marked each year. Those streets which have had several annual treatments seem to have changed their character and to have taken on characteristics other than those of water-bound macadam streets. The change is so marked that it would almost appear as if a new type of pavement has been created. The effect of these annual treatments on maintenance costs is quite evident and indicates a marked decrease in expenditure, as it is a comparatively easy matter to maintain such a street in good condition by the "Bituminous Patching Method," and the life of such a street is undoubtedly prolonged out of all proportion to the cost of such treatments.

Correcting Disadvantages

There seems to be very few disadvantages connected with the application of surface treatments, and these can be corrected by proper care in the prepaartion of specifications and proper inspection for adherence thereto. The greatest difficulties seem to be incident to the fact that macadam street surfaces are not uniform in texture, due to the comparative recentness of construction or repair, to the number and frequency of previous treatments, to traffic conditions and to the character of material used in the construction and repair. These conditions must be taken into consideration in making up specifications, as the amount of oil, tar or asphalt necessary to treat the street properly is directly dependent on the porosity of the street surface, but this can be regulated by taking bids on a sliding scale of amounts of material per square yard.

Most Important Factors

I think that the most important factors in obtaining a good treatment are, first, a thoroughly clean, hard street surface; second, proper weather conditions at the time of treatment; third, accurate selection of the most suitable material, and the applying of the proper quantity; and, fourth, thorough sanding with shot gravel after the treatment.

The value of these treatments is becoming increasingly evident, and they may become almost universal where the proper materials are available.

Procedure in Maintenance of Asphalt Pavements in Buffalo

By C. E. P. Babcock, First Assistant Engineer, and J. A. Vandewater, Assistant Engineer in Charge of Repairs, Department of Public Works, Buffalo, N. Y.

With the expiration of guaranties of the first asphalt pavements and the assumption of repairs by the city out of its general fund, a detailed record was entered and carried on. Having had no experience in the cost of asphalt repair and little, if any, information being obtainable in this country, it was perhaps as much an engineer's curiosity or wonder, rather than a pre-determined appreciation of the magnitude and importance of knowledge of cost of future repairs, which developed our present method of recording.

Records of Costs

From printed reports the cost of each street, each year, can be ascertained. As the life of asphalt pavements in Buffalo is (with few exceptions) 20 years or over, these records have assumed a considerable volume and the question arose as to whether their value justified the space and the cost of printing year after year.

Fortunately it was decided to continue the record, leaving off the early details and publishing the area and cost in detail for 10 or more years back.

As example:

Cost of repair before
1910————Total and rate
Area, cost and rate since
1910 in detail, Annual

This seems to have satisfied the objection, and probably this method will be continued.

These tables are beyond the interesting stage and have become a necessity, and are more referred to than many other mere tables, for this reason: the question always arises as to whether a street has received an adequate repair, whether the city should carry it on. As two-thirds of repaving is assessed, of course the local desire is to postpone the local expense regardless of the engineer's advice. These tables, showing yardage and cost of repair, form a basis for argument and determination. Beside this we locate and plot on cross-section paper every patch repaired, using different colors for each year. These plottings show, not only the yearly repair, but more important, where repair overlaps previous repair. The contractor guarantees his work from December 31 of the year in which they are made for one year. Therefore, if a repair is made over-lapping the joint of a repair under guaranty an allowance of 6 ins. is made and not charged to the new guaranty.

Basis of Repair Contracts

Heretofore our contracts were made on the basis of a square yard repaired. For our resident asphalt contractors this seemed a fair basis because, after experience, they knew about the amount of the season's work and the material required for it.

In 1908 our investigation showed that of the original depth of the asphalt, viz: 1½ ins. of binder and 2 ins. of wearing surface about 52% depth binder was used in repair and about 82% top (see 75 and 78% later on).

If an outside company wished to bid on the square yard basis they would not have had this experience. With our own knowledge of the conditions we felt that our contract should be made on something different than the square-yard measurements for the materials used. It is of course known by the engineers and contractors that the binder costs less per cubic content than the wearing surface.

While there probably was not a pre-fixed idea of the contractor when his bid was submitted, that he could manipulate the use of the binder and top to his advantage, yet the opportunity was there, and in a city contract an opening of that kind is open to criticism if not something worse.

Provisions of Specifications

Therefore, after collecting the data available, the Department of Public Works authorized a new specification, the principal factors in which are that:

Both top and binder are purchased at the plant of the contractor by cubic measure, the price including delivery on the work.

The asphaltic cement for painting joints is paid for by the gallon delivered.

The cost of the street work includes labor, the chopping out of patches, laying material and cleaning up. This we pay for by the square yard.

Our contract also provides for relaying concrete base, unless the city performs the work with its own force.

Also for paving in trenches with binder 1½ ins. deep and top 1½ ins. deep and labor—a price being bid

For trenches under 80 sq. yds.

For trenches between 80 and 480 sq. yds.

For trenches between 480 and 1000 sq. yds.

For trenches over 1000 sq. yds.

If two or more trenches of this kind are within one-half mile one from another and are repaired as a continuous work, the sum of their areas is the area on which payment is made.

By this specification the city uses all of either the binder or the top as its engineer requires and pays for the amount actually used. Our specifications quote that the average depth experience was for binder 1.12 ins., top 1.57 ins. or 75 and 78% of original depth, and this definition we make for the information of the bidder.

In the 1917 work we found that we used about 0.87 in. average depth of binder and 1.57 in. of top, or 58 and 78% respectively. The reduction in binder is partly due to the fact that our pavements are becoming thin. Those laid prior to 1912 were laid on ½ in. cushion instead of binder, and these require little, if any, binder in repairs. Our specifications provide that when the old pavement is less than 2 ins. deep binder shall not be used for repair.

Bids for repairs are received early in the calendar year, giving the contractor time to order his material and to arrange his organization.

As soon as the weather permits, usually in March, an inspection of all pavements is made, conditions are noted, and a list of streets to be repaired is prepared, streets in the downtown or business section and the principal thoroughfares being taken care of first. We endeavor to repair all our asphalt pavements at least once a year and this has been done with a few exceptions. Pavements that have unusually heavy traffic are repaired twice a year when necessary.

Work is begun about April 1 and usually continues until about December 1. The pavements to be repaired are marked out by what we term an Asphalt Locator, who is assisted by boys who measure up and locate the patches and a man to record same in field book. The contractor also furnishes a man to keep a record of the size of the patches, and his records must correspond with those made by city's locator. The repair gang then follows, chopping out, relaying the new material and cleaning up; a gang laying from 750 to 1000 sq. yds. per day depending upon the size of the patches. All old material is the property of city and removed to dump provided by contractor or wherever the engineer may direct.

Quantities and Costs

The work is done by two large gangs consisting of about 75 to 100 men each, foremen, teams, trucks and rollers. There is also a small gang employed repairing cuts made by the Bureau of Water, plumbers, corporations and others, and two gangs where necessary.

During the last 15 years or up to June 30, 1917, about 3,000,000 sq. yds. of asphalt pavement have been maintained annually; the greatest number of square yards being 3,139,731 in 1911 and the least 2,858,634 in 1916.

The average cost per square yard on total yardage maintained has varied from $0.0162 in 1903, due to the small appropriation available for this purpose, to $0.0827 in 1913; the average for the last 15 years was a little over 5 cts per square yard. But this rate does not represent the necessity of repair which the department might recommend, but is influenced by the funds available. The last 5 or 6 years the appropriation for this purpose has been very fair.

The contract price has varied from 74 cts. to $1.39 per square yard laid up to Dec. 31, 1917, and on account of the high cost of labor and material this year, the rate may run somewhat over $1.80 per square yard laid.

Up to June 30, 1917, $2,899,781 has been expended on repairs to asphalt pavements. The average rate per square yard in area of the streets repaired being $0.0653 and on the area maintained $0.0451.

Cutting Out Patches

In 1917 a gas-driven cutting machine was devised by one of the contractors to cut out patches, action similar to that of a pile driver. It is not altogether satisfactory, particularly on old pavements where it often breaks contiguous pavement. Our experience is not sufficient to warrant an extended criticism. A rather specious argument for its use is that it acts as a sort of balance wheel for labor and axes, when the labor looks for higher wages; but for good workmanship we have not found a mechanical cutter that compares with a man and axe.

It should be recognized that additional life is added by making adequate repair.

It is perhaps not possible to establish an exact relation between the advisable expenditure on repair as compared with the life of a pavement, because of the variables: 1st, cost of labor and material; 2nd, continuation of proper maintenance; 3rd, increase or change in traffic.

A total of 64,300,000-year-yards repair of paving, carrying 5-year guaranty prior to 1898 and 10-year guaranty on pavement laid since 1898, show an average annual rate of $0.045 per square yard. The present average age of all asphalt pavements under city maintenance is about 21.7 years.

The foregoing is a paper presented before the recent convention of the American Society of Municipal Improvements.

Data on Performance of Motor Apparatus Operated by Bureau of Streets, Buffalo, N. Y.

By William F. Schwartz, Street Commissioner, Buffalo, N. Y., in Address to American Society of Municipal Improvements

The city of Buffalo at the present time has two Elgin motor sweepers. These sweepers were bought and placed in operation on Oct. 1, 1916, replacing six horse-drawn sweepers and two sprinkling wagons. They work two shifts, 8 hours each per day, namely, 3 a. m. to 11 a. m. and 4 p. m. to 12 p. m. They are a combination sprinkler, sweeper and pick-up, being equipped with a 200-gal. tank, large circular broom and 1½-cu. yd. box. The motor power is a 45-h. p. engine.

During the past year three motor street-flushing equip- approximately 72,000 great squares (a great square consists of 10,000 sq. feet). We find they did the best work on smooth pavement, and that the cost per great square was about 2c lower than in horse-swept districts. On account of the abnormal times we have had considerable trouble in getting competent drivers, consequently the machines have not been worked as satisfactorily as under normal conditions.

During the past year three motor street-flushing equipments were installed by the department to replace the old method of flushing and, in some districts, street cleaning.

The Equipment

In constructing and designing this equipment the department took into consideration—1st, cost of equipment; 2nd, length of time of service; 3rd, operation and maintenance; 4th, size.

From the above we specified a five-ton tractor with power-take-off from transmission to pump that delivers pressure for flusher; a trailer with 2,000-gal. tank capacity set upon the fifth wheel on tractor. Tractors in operation are the five-ton Pierce-Arrow of standard design, with exception of power take-off of 15 h. p. and are geared 42 to 1. The tractors are equipped with dual 36-in. tires rear and single front.

The trailers and pumps are manufactured by Chas. Hvass & Co., of New York City, and are provided with cylindrical tank, four nozzles which are controlled from driver's seat, centrifugal pump driven from power take-off, also controlled from driver's seat. The pump creates a pressure of 35 lbs. (this pressure can be increased or decreased). We find that 35 lbs. will not injure the pavement and at the same time does cleanly work. When the street is very dirty we use the four nozzles, which gush 525 gals. per minute, but as a rule we only use two nozzles which flow 150 gals. per minute. During the process of flushing, the tractor runs at a speed of 4½ miles per hour, running empty 14 miles; weight of tractor and flusher when full 18 tons, when empty 10 tons.

Use of Equipment in Snow Removal

During the winter season the trailers are removed from tractors, and the tractors are placed in operation in snow work, also hauling trailers for ash and garbage districts. We estimate during the past winter that these three tractors saved the city at least $15,000 in snow work alone. A great many of our streets in the outlying districts became drifted

and it was an utter impossibility for the city to get labor to remove it, notwithstanding the fact that we placed every available prisoner which we could commandeer from the penitentiary. We equipped the tractors with Good Roads snow plows and found they did excellent work.

Operating Costs

The cost of operation per day (which includes operating charges, maintenance and fixed charges) for a 16-hour day we found to be $24.96; during the winter months this cost increased $2 per day on account of more gasoline and oil being used by being forced to run low gear the greater part of the time on account of bucking heavy drifts of snow.

Under the old system of flushing with portable line hose the cost per great square for 10,000 sq. ft. was $1.40. We experimented with the two-man reel (used in New York City) and found the cost to be 56c. The motor equipment reduced the cost to 20½c per great square; this includes everything, such as operating labor, supervision and pick-up wagons.

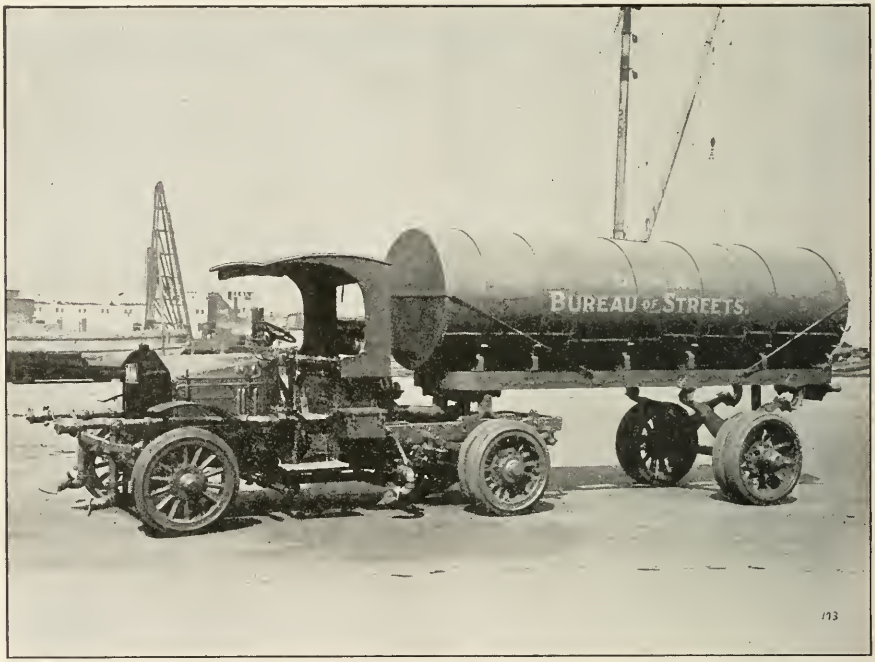
The city has contracted for three additional flushers, and it is the intention of the department, as soon as financial conditions warrant, eventually to do away with all horse-drawn sweepers and sprinklers and flush the entire town with the exception of cobblestone and macadam pavements, as we find the cost per great square for sweeping is $0.278 and that of flushing is $0.205. Motor equipment is not only more economical than horse-drawn equipment but leaves the streets in a more cleanly and more sanitary condition.

Motor Equipment in Ash and Garbage Division

For two months we demonstrated with trailers and tractors in the Ash and Garbage Division and found we could cut the expense approximately 25%, also getting greater efficiency. The system followed in the demonstration was to start empty trailers drawn by horses from various barns to the different districts. When these trailers were loaded tractors with a train of four empty trailers dropped the latter and took up the loaded trailers and proceeded to the dump or reduction plant, continuing this operation until the districts were cleaned up.

At the present time we have six Ford motor trucks in operation in the Ash and Garbage Division. These trucks have a capacity of 4 yds., but have only been in operation for four months, consequently we cannot get a definite line upon the maintenance and depreciation. The class of drivers we are able to get are inexperienced (being mainly boys of 17 to 19 years of age) so that these trucks are often laid up for repairs. In the writer's opinion this form of truck is too light in weight for collecting ashes, for the reason that the dumps through which they have to go have a tendency to jar the entire machinery badly on account of their light construction.

It is the intention of the department, after we have won the war, to motorize the entire Ash and Garbage Division.



MOTOR FLUSHING AND SPRINKLING UNIT OPERATED BY BUREAU OF STREETS, BUFFALO, N. Y.

Relative Efficiency of Methods for Repairing Bituminous Macadam and Bituminous Concrete Pavements

By George H. Biles, Acting Chief Engineer, Pennsylvania State Highway Department, Harrisburg, Pa.

In recent years there has been marked development in the methods of repairing and rehabilitating bituminous pavements. There are innumerable instances where pavements had apparently arrived at a stage of such failure that their entire reconstruction seemed justifiable, but by the scientific, efficient and economic methods of the Highway Engineer they have been repaired.

Bituminous Macadam Pavements

Bituminous macadam is represented principally by the penetration method types of pavement. Before taking up the efficiency of the actual methods of repair, some of the fail-

ures and causes of disintegration common to these types of pavement will be described briefly.

Causes of Disintegration of Bituminous Macadam Pavements

The most common deficiency in this type of work is found in the non-uniformity of the surface.

Raveling

As an example, we have first a section of road where the surface is composed of spots of excess bituminous material and bare or lean areas where the binder is lacking in quantity, which condition results in a short time in a raveling or breaking up of the road surface. This condition is usually caused by improper distribution or by incorporating the bituminous material when the stone is not thoroughly dry.

Pot Holes.

Second—A rough surface is presented where the stone is loosened or raveled, the binder showing rapid deterioration, generally causing a series of pot holes. This may be occasioned by improper or overheated bituminous material, unsatisfactory aggregate or faulty sub-drainage.

Insufficiency of Bituminous Material

Third—At times we have apparently a lifeless surface insofar as the bitumen is concerned, but upon further examination it is found to contain bituminous binder with considerable life a slight depth below the surface. This condition is due in many cases to an insufficiency of bituminous material.

Excess of Bituminous Material

Fourth—A pavement may present a wavy and uneven appearance and this is usually due to an excess of bituminous material or is caused by the bituminous material being too soft to withstand the action of traffic.

Improper Pouring

Fifth—There are surfaces which consist of ridges of material which are the result of irregular or improper pouring—in most cases, careless hand pouring. A surface of this kind suffers quickly from the impact of traffic and the attack of the elements and early disintegration is the result.

Sixth—We have a fairly well shaped, uniform surface becoming porous. This condition is true of all bituminous highways in time as it represents the beginning of the deterioration of the bituminous material.

Method of Repairing Bituminous Macadam

Taking the several conditions in the order mentioned, the first case, if taken in time, can be repaired by sealing the dry or lean spots in the surface with a light, heated application of bituminous cement of the binder grade, or the cold bituminous surface treatment materials in quantities ranging from 1-10 gal. to ¾ gal, to the square yard of surface, covered with chips or pea gravel, using between 15 and 20 lbs. to the square yard. Unless the surface is worn badly, repairs of this character will even up the surface to a true cross-section, giving added life to the pavement.

Scarifying and Harrowing

The second condition calls for heroic treatment if of any great extent and a complete scarifying and harrowing of the surface becomes necessary. All disintegrated material must be removed and sufficient new stone added to give the required depth before the surface can be repenetrated and sealed as in the original construction. If, however, the affected portions are only occasional and do not represent the greater area, they may be cut out, cleaned thoroughly and filled with new stone, making due allowance for compression, then penetrated, etc., in the manner hereinbefore mentioned. If drainage conditions are responsible for the failure, they must be corrected before any surface repairs are taken up.

Filling Surface Voids

The condition described in the third example may be treated in two ways. The most economical, so far as first cost is concerned, would be to give the pavement a treatment in sufficient quantity to fill the surface voids, with a material that will penetrate and enliven the old material, followed by a covering of good, hard stone chips, using about 20 lbs. to the square yard. The alternative would be to scarify and harrow the whole surface, supplying additional new stone in quantities as the rolling would indicate it to be required to give the proper cross-section, and penetrating the surface with a bituminous binder, sealing again as in the original construction. In the latter method, the surface must first be thoroughly cleaned and in scarifying and harrowing, the remaining bituminous material in the road must be distributed as evenly as possible. If the material found in the pavement, however, does not possess life, this method is a hazard.

Reshaping Surface

In the wavy, corrugated surface, where there is found to be an excess of bituminous material, it is generally more economical and satisfactory to scarify and reshape the surface, adding new stone in order to take up the excess bitumen, and again sealing the surface. This same method should be followed where waves have been caused by the bituminous material being too soft only, perhaps, more stone would be required in the reconstruction and it would be essential to incorporate a harder bituminous binder than was used in the original construction.

Occasional waves in the surface may be taken out in the due course of ordinary repairs by cutting off the high places and resealing, if the conditions are very pronounced, or by cutting out the depressions and replacing with new material.

Painting Between Ridges

A surface full of ridges due to improper pouring, if not too pronounced, may be evened up by painting between the ridges with bituminous cement and covering with stone chips or gravel. This method may be continued from time to time until the surface is entirely evened up. This condition may also be corrected by scarifying the surface with the object of obtaining a more uniform distribution of the old bituminous penetration pavement but the bituminous material is applying a surface treatment of a cold bituminous material that will enliven the existing material and seal the surface. This treatment is covered with stone chips in the manner prescribed for regular bituminous surface treatment work.

Applying Seal Coat

In the last case, we have a properly constructed bituminous penetration pavement but the bituminous material is starting to deteriorate. This can be enlivened or revived by cleansing the surface and applying a seal coat of material in quantities depending upon the degree of disintegration. Caution should be exercised to avoid applying an excess amount, which results in a slippery condition and is very objectionable to horse-drawn traffic. Generally 1-10 to 1-6 gal. is used and brushed into the surface with hand brooms. The surface is then covered with chips or gravel approximating 20 lbs. to the square yard. In the use of certain slow drying cold bituminous materials it will be observed that the new material softens up the old bitumen somewhat, giving the appearance at first of an excess application, and, having a hard surface underneath the road becomes quite slippery, but this condition obtains for only a short period of time.

To insure the best results, one-half of the road should be treated at a time in order that the traffic may use the other portion while the bituminous material is setting up. This method has become quite effective and results in increased life to the pavement.

Hot Bituminous Binders

In the repairs of breaks, depressions and local defects,

which may occur under any one of the general conditions previously outlined, it is more satisfactory to use hot bituminous binders, and if replacements are necessary they can be made after the fashion of the original construction. This work can be done very efficiently in this manner with little equipment and the average class of labor. There are a number of instances where cold bituminous compounds can and are being used successfully in certain seasons of the year on pavements of this kind, but in cold weather there is usually difficulty with some of this material, owing to its composition. As an example, the emulsified products break down or separate and their adhesiveness is destroyed at low temperatures. Materials that are cut back with natural solvents can be used later and give very good results. The mixtures can be prepared at some point not exposed to the weather but convenient to the work, hauled to the site of the repairs, and deposited. This is an effective method in case of emergency.

Bituminous Concrete Pavements

The various mixed bituminous pavements, with the exception of sheet asphalt, are included in the class of bituminous concretes. Different streets, in spite of the fact that they have been constructed of the same material present different appearances. Cracking of the surface is one of the greatest as well as one of the earliest defects that may develop in bituminous pavements. This may be due to one cause or a combination of several causes. Frequent cases are noted in bituminous wearing surfaces which, although apparently satisfactory mixtures in all other respects, contract as the base contracts and crack open at exactly the same point as the foundation. Again, cases are noticed of otherwise satisfactory pavements which crack because ot their failure to receive the amount of traffic necessary to give the pavement its full compression or to iron out and close up the surface after low temperatures have tended to open it up by stretching the bituminous binder.

Effects of Improper Design

A condition of the sort last described, however, may have been hastened considerably or even caused directly by what might be called improper design of the pavement in the first place.

The bituminous surface mixtures expected to receive heavy traffic should be tough and fairly hard in order to resist displacement. Those designed for light traffic should be softer and more yielding, and this is accomplished by using a softer bitumen—that is, one of a higher penetration. Failure to do so means that as the pieces of mineral aggregate contract or shrink in volume during cold weather, they exert a spreading force in the surrounding bitumen which it cannot withstand because of its lack of light fluxing oils and corresponding ductility or ability to stretch; in other words, pavements containing hard or non-ductile bituminous material will have a greater tendency to crack in cold weather. Similar results and even general disintegration of the wearing surface may have been produced by too little bitumen in the mixture, since this is largely a measure of the life and elasticity of the pavement, and, similarly, overheated mixtures suffer a hardening and reduction of bonding power of the bitumen with consequent tendency to crack and wear. Aside from faulty drainage, poorly proportioned mixtures and unsuitable ingredients contribute largely to the failures in this type of pavement.

Disintegration

A bituminous concrete pavement which is satisfactory in all other respects may show surface indications of slight disintegration. The material in all probability has been attacked by the elements and evidence of wear is shown as the gloss is gone and the discoloration of the surface, which approaches a light brownish hue, is noticeable. This is speedily followed by a general porous condition and, if not promptly attended to will allow the surface to retain moisture which will eventually break the bond of the material and result in raveling and failure of the pavement.

Wavy Surface

The wavy condition of the surface found in the bituminous macadam roads is also common to the bituminous concrete types. This condition is usually found on well-traveled streets, especially on grades, and is caused mostly by the bituminous mixture being too soft, which gives it a tendency to push under traffic. A wavy surface may be attributable to the methods used in the construction of the pavement for, if in the building the material was not at a temperature suitable for raking to a uniformly loose condition, or crept under the roller as a result of careless handling or being rolled while too hot, an irregular surface would result. Pushing or waving in local spots may often be traced to the laying of the mixture on a dusty or dirty surface.

Deterioration Along the Edges

The wearing and deterioration along the edges of bituminous pavements where there is no header, is responsible for one of the most troublesome and expensive forms of repairs to roads of this type. The traffic continually irons out the surface along the edges and this spreading or flattening out produces a feather edge along the sides. The moisture and foreign material tracked on from the shoulders soon attack the bituminous material and result in the crumbling or breaking away of the surface which occasions extensive repairs. This condition is more pronounced when the material in the shoulders is of a non-porous nature or is poorly drained.

Methods of Repairing Bituminous Concrete.

In the repairs to the bituminous concrete pavements, special care is required in determining the methods and materials to be used. Taking the several conditions enumerated in the foregoing in their order, we first have a cracked bituminous surface and, unless the cracks are caused by some serious form of disintegration in the pavement, they can be repaired by cleaning them out thoroughly and pouring them full of either a hot or cold bituminous material of the proper grade, and thereafter tamping or wedging stout chips into the crack, thoroughly sealing it. If the crack is wide enough and the edges have crumbled or broken off, they should be cut down evenly and the opening filled and tamped with a mixture of the bituminous cement and stone chips in a proportion of one part bituminous cement to nine parts chips, in sufficient quantity to insure complete closure.

New Surfacing

When the entire surface is cracked or broken and is uniformly bad and gradually crumbling away, due to the disintegration of the material from any of the several causes hereinbefore mentioned, it becomes necessary to remove the old material and replace with a new surface. If the condition exists only in local spots this will develop into pot holes or depressions, which can be repaired by cutting out the affected areas down to the foundation and replacing with a new mixture.

Character of Bituminous Material to Use

The character of the bituminous material to use depends entirely upon the conditions in each case. Unless the repair work is extensive, it is not deemed advisable to use hot bituminous compounds in this work, not only from an economic standpoint, but from a point of convenience as well. Small repairs in the proper season can be handled economically and efficiently with cold bituminous cement, and if the proper mixture is used in the regular working season excellent results can be obtained.

Patching with Other Materials

It is conceded that hot bituminous repairs are not gener-

ally satisfactory when made at low temperatures, but in some places the avoidance of this practice has been carried almost to a fault. As an example, in some of the larger municipalities where defects have developed in the surface during the winter months, the affected portions have been removed and repaired with brick or stone block. This method is not only objectionable on account of the annoyance to traffic but, when the regular season for repairs arrives, it is usually found that additional work is required, occasioned through the inequality of the surface. It has been stated by some of the advocates of this method that it is an assurance that the affected portions will not be overlooked when the repair work is taken up in the spring. It has been demonstrated, however, that where conditions are so acute that this method is warranted, there is justification for making special arrangements for preparing and placing a suitable bituminous mixture which will be more satisfactory in the interim and, whereas, probably not a complete success, will offer as good, if not better, opportunities to correct later than the first method, which seems only to be justified when repairing cuts made in the pavements by public service corporations in the winter season.

Light Surface Application

When the surface of a bituminous concrete pavement begins to show that the bituminous material is disintegrating and the surface has a dry, porous appearance, similar to the appearance of the bituminous macadam pavement previously described, the surface can be revived by a light bituminous surface application the same as in the former case.

Reconstruction of Wavy Pavements

The wavy, irregular surface on bituminous concrete pavements is one of the most unsatisfactory conditions pertaining to the bituminous type of pavement. It is a defect that in most cases is proof positive of the inability of the pavement to meet the traffic requirements, except when the fault may have resulted from the methods used in the construction rather than the materials. If the materials have been found unsatisfactory and the irregularity of the surface is increasing steadily, reconstruction will eventually be necessary.

If the surface is only affected in local spots due to any of the other causes enumerated, this area may be removed and replaced with a new mixture which has been properly selected and strict attention should be given to the requirements of the mixture in order that a repetition of the original deficiencies cannot obtain.

When the proper material has been used in the original construction and the surface is irregular through careless methods in spreading, beneficial results can be obtained from rolling the surface in hot weather with a tandem power roller operated by a competent man.

Repairing Edges

In the repairs to the edges of a bituminous pavement not confined by headers, the first and most essential thing to do is to correct the cause, if possible. If the drainage of the shoulders or base is faulty, this should be taken into consideration first and ample provision made therefor. On shoulders which are composed of non-porous material, it is advisable to cut scuppers or small surface ditches at intervals of approximately 20 ft. along the road and, in addition to this the material immediately along the edge of the pavement should be replaced for a depth of a few inches with broken stone or gravel tamped into place to produce a more stable buttress for the new bituminous material. The patches should be made by removing the affected area and replacing with new mixture. Successful repairs should neither be above nor below the surrounding surface when finally compacted.

Central and Portable Mixing Plants

In municipalities where there is enough yardage to warrant a central mixing plant, this is the most satisfactory method of handling bituminous repairs. With every facility at hand to compound the mixture properly, more uniformity is assured and much of the personal equation resulting from separate organizations is eliminated. There are localities where possibly small portable mixing plants would meet the requirements and give satisfactory results. However, under ordinary conditions, the problem is generally a small town with probably several short streets or some other unit, such as a county or state, with continuous stretches of miles of interurban bituminous pavements or highways. In either case, it means one or a number of outfits performing the repair work, which conditions give strength to the demand for simple and efficient methods. With trained men, good hot bituminous mixtures have been prepared by hand, but considering the chances taken in overheating the material the careless proportioning and mixing and the extra expense in connection with the handling of the equipment, etc., it does not justify this method.

Cold Bituminous Mixture

The cold bituminous mixture with the proper material is the most economical and fool-proof method for ordinary repairs. The material can be mixed on a regular mixing board, stock prepared for future use, if need be, and stored at convenient intervals along the road and, aside from the small tools, such as shovels, rakes and tampers, no other equipment is absolutely necessary. Repairs have been made with cold bituminous mixtures on extremely heavy traveled roads that are in excellent condition after four seasons of wear.

Acknowledgement

The foregoing discussion is, slightly condensed, the paper presented by Mr. Biles before Section "D" of the American Asosciation for the Advancement of Science on December 28, 1917.

How Various Cities Meet Repaving Costs

An inquiry recently made by the Commission of Publicity and Efficiency of the city of Toledo, concerning the practice in other cities, indicates a tendency in the East to place repaving costs on the municipality, while in the West the general practice is to assess most of the cost against the abutting property.

New York and Seattle

This fact is borne out by a statement from Prof. Robert M. Haig, of Columbia University, a recognized authority on the subject. In a letter to the commission, written in answer to a query, Prof. Haig declared: "There is the greatest diversity of practice in assessing the cost of repaving. Here in New York City the property owners can be assessed for only one first-class pavement. But this is a rule which has grown up because of abuses in the direction of extending installments over unreasonably long periods. Farther west, particularly in the far West, the opposite practice prevails. For example, Seattle has recently paid for the repaving of its main street by special assessments."

Thirty-One Minnesota Cities

A report made by the League of Minnesota Municipalities shows that of thirty-one towns and cities in that state, eighteen of them assess all improvements against benefited property, eight pay the entire cost out of the general fund and five divide the cost between the city and property owners.

Los Angeles and Buffalo

In Los Angeles the whole cost of any improvement may be charged to the property owner. There is no restriction on the assessment. The city council may fix the city's portion at its own discretion.

In Buffalo, on the other hand, the charter provides that

when a street is repaved or resurfaced, not more than two-thirds of the expense may be raised by local assessments. The remaining one-third must be paid out of the general fund.

Columbus and Akron, Ohio

Columbus has a unique plan of dividing the cost. The city's share of original improvements is the same as in Toledo, with a minimum of 2 per cent plus intersections. But the charter provides that "Whenever an assessment is levied for the replacement of any improvement for which an assessment has theretofore been made, there shall be deducted from the assessment that might otherwise be made for such replacement, at least one-half of the amount paid on the assessment for the original improvement." The amount deducted is then added to the city's share.

In actual practice, however, the city of Columbus pays half the expense of repaving jobs, plus intersection costs, just as is done in Toledo. The commission was so informed by the Columbus Bureau of Information and Publicity.

Word comes from the city engineer of Akron that, unable to meet the costs of repaving on the plan of 50 per cent by the city and the rest by property owners, the city has refused to have work done unless the owners agree to shoulder the entire cost. Where this plan has conflicted with the prohibition against assessing more than one-third the value of any property, the work has been left undone.

From Workers in Field and Office

Water Waste of 9,000,000 Gals. per Day Eliminated in Buffalo, N. Y.

To the Editor:

It may be of interest to your readers to know that in the City of Buffalo we have eliminated water waste amounting to 9,000,000 gals. a day, due to underground leakage alone. These leaks were all discovered by means of the Pitometer Survey and there was no evidence of them apparent on the surface.

In our work up to date, we have covered less than one-half the city. The total reduction in consumption up to date, due to elimination of waste of all kinds, is 35,000,000 gals., based on an estimated figure for the probable average daily pumpage of 1918, had no steps been taken to eliminate waste. This figure was based on the average yearly increase over a period of ten years.

E. D. CASE,
Manager, The Pitometer Co.

New York City, Sept. 13, 1918.

Some Large Wood Stave Pipe Lines on Power Installations

To the Editor: The 46-in. continuous wood stave pipe which we installed for the Hydro Electric Power Commission of Ontario, at Eugenia, is 3,400 ft. long and operates under a head of 100 ft. The staves were made from British Columbia fir and are 2 ins. thick. The steel bands used are $\frac{5}{8}$ in. diameter and connect with malleable cast iron shoes. This line was installed in 1914 and has since been in continual use, giving every satisfaction to the purchasers.

The foregoing size of pipe is by no means the largest we have constructed. In the Cobalt region of Northern Ontario we have built a 9-ft. and an 11-ft. pipe for the Northern Canada Power Company. Throughout British Columbia we have built many lines ranging in diameter from 3 to 4 ft., with heads running as high as 400 ft. We have one line 6 ft. in diameter which has a 310-ft. head at the junction of wood stave and steel pipe.

We are now engaged on another contract with the Hydro Electric Power Commission for a wood stave pipe 13 ft. 6 ins. diameter, $1\frac{1}{4}$ miles in length, at the plant of the Ontario Power Company, Niagara Falls.

In all cases the best quality British Columbia fir is used for the staves. Stave thickness varies according to the size and pressure of the pipe. The material is manufactured at our plant here and assembled by our forces on the ground.

Pacific Coast Pipe Co., Ltd.,
Vancouver, B. C. By H. C. James, Secy.-Treas.

Reports Indicate Increasing Use of Trenching Machinery by City Water Works Departments

Since the publication in Municipal and County Engineering for September of the article relating the success of the Board of Water Commissioners of Detroit, Mich., in offsetting man shortage and rising costs by using machinery for water main extension work, a number of reports have been received from other cities indicating a quite general adoption of labor-saving machinery wherever municipalities have had any considerable amount of trenching to do this season.

Mr. L. J. Clancy, assistant general superintendent of the Detroit Board of Water Commissioners, writes as follows: "Your article as a whole is very good and covers our situation thoroughly. The cost data on trenching machinery is not in such shape just yet that accurate figures are obtainable, but I would venture to say that the trenching machinery has cut our costs in half besides solving the labor problem. In 1915 it cost $2.45 per lineal foot for digging a trench for 48-in. pipe and this year, using a steam driven Austin machine, it cost about one-sixth of that amount. The Buckeye and Austin machines used on trenching for 12, 8, and 6-in. pipe rendered equally efficient service and cut costs one-half or more."

A trenching machine and backfiller have proved a good investment for Buffalo, N. Y. Writing of his experience with trenching machinery as water commissioner of the city of Buffalo, Mr. George C. Andrews says:

"In May, 1918, we purchased a No. 00 Austin Trencher and No. 2 Austin Backfiller for use on our extension work. The reason the department purchased these was the fact that in 1917 it was impossible to obtain labor to work on city ditches, and also, that war work demanded considerable work in the outlying districts of the city where it would be possible to operate trenching machines without hindrance. Shortly after purchase of these machines it was necessary for the department to lay 9,600 ft. of 36-in. main to supply essential war industries with water. While this Austin machine we own is only designed to dig 3 ft. 6 ins. wide, it was possible for us to dig a 4-ft. trench with it and the line was so laid out that the machine was used on 3,179 ft., which was dug in actual operating time of 93 hours. This is by no means the capacity of the machine. The average depth of this trench was over 7 ft. Besides the work on the 36-in. line, trenches were dug for 6,457 ft. of 6-in. pipe; 1,070 ft. of 10-in. pipe and 2,830 ft. of 16-in. pipe. The backfiller has also been a great labor saver."

Mr. Ray Crozier, engineer and superintendent of the Peoria

Water Works Co., Peoria, Ill., writes: "Our Parsons trenching machine was purchased in 1916 at the time when the shortage of labor was beginning to be felt, also when the wages of laborers began to advance. We consider our trenching machine very necessary at the present time on account of the extreme labor shortage."

At Minneapolis, Minn., water main extension work has been considerably curtailed during the past season. The water works department owns a large Austin trenching machine but such work as was done this season was for small pipe, requiring a smaller machine. Mr. J. A. Jensen, supervisor of water, writes that it has been impossible to maintain the crews at even 50 per cent. of the usual strength and in conclusion says: "We have a large Austin trench excavator used on heavy work two years ago, and we hope to have similar machinery for smaller mains in order to effect the economy that is possible by their use."

Mr. F. P. Lannon, acting general manager of the Metropolitan Water District of the city of Omaha, Neb., states that the Parsons trenching machine used by his department has made a decided saving in labor costs, but the exact figures are not yet available.

Mr. Owen T. Smith, secretary and superintendent of the Freeport Water Company, Freeport, Ill., reports that his company used a Buckeye trenching machine to such good purpose that the price of the machine was saved several times over in laying 17 miles of 4-in. to 16-in. mains which had to be completed within a short period of time to comply with franchise requirements.

The water pipe extension division of the Chicago Department of Public Works maintains one construction gang equipped entirely with machinery. This gang is supplied with three Austin trenching machines; one large machine for 48-in. main jobs and two small machines for digging trenches for 6 to 24-in. pipe. This gang is also supplied with two pneumatic air compressors for operating calking hammers, an Orton & Steinbrenner locomotive crane for handling large pipe, one large capacity gasoline-driven trench pump, and various smaller equipment.

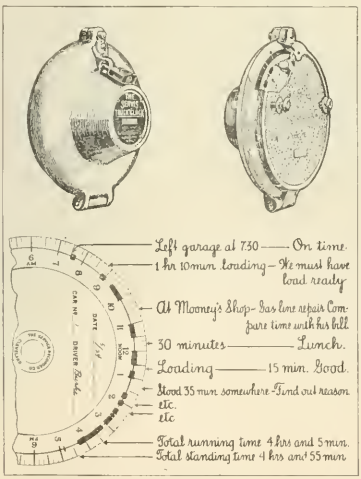
Supt. Ed. W. Humphreys, of the Erie (Pa.) Water Works, reports on the speed with which his department has been able to rush water main extensions to new industrial sections of Erie by utilizing a Pawling & Harnischfeger trenching machine. Work was carried on right through last winter and results were obtained that would have been impossible with hand labor, even if laborers could have been obtained.

Plant Units and Lay Outs

Device for Recording the Movements of Motor Trucks

A mechanical device for recording the movements of motor trucks from minute to minute throughout the day is here illustrated. A sample record is also shown. This device has just been placed on the market by the Service Recorder Co., of Cleveland, Ohio.

Such items as these are shown in the record: when the truck reported for work, how long it took to load, how long to make various trips, when each delay occurred and the length of each delay, how long it was held up at the freight station, or at the shipping dock, or in the yard, and many other interesting facts, including when the truck turned in at night, and whether it was used during the night.


Left garage at 730 — On time.
1 hr 10 min loading — We must have load ready
At Mooney's Shop — Gas line repair Compare time with his bill
30 minutes — Lunch.
Loading — 15 min. Good.
Stood 35 min somewhere Find out reason
etc.
etc.
Total running time 4 hrs and 5 min.
Total standing time 4 hrs and 55 min

DEVICE FOR RECORDING MOTOR TRUCK TRAVEL WITH SAMPLE RECORD.

It records this information on a paper disc. This disc is laid on the desk of the dispatcher or other official of the operating company. And when he comes to glance over it he finds out that in nine cases out of ten, the driver is not to blame for expensive truck delays. Instead some department of the business is at fault. Then he revamps his shipping department, puts in quick loading devices, arranges his routes on a scientific time schedule and perhaps saves an hour a day.

The side-sway is pronounced in the motion of the motor truck, and is present no matter how smooth the road or how straight the line of travel. It is entirely distinct from vibration and should not be confused with it.

This side-sway, then, tells that the vehicle—whether motor truck, horse-drawn wagon, locomotive, or even motorcycle—is in travel motion, and the absence of it indicates that the vehicle is standing. This instrument not only records this side-sway, but records it when it happens.

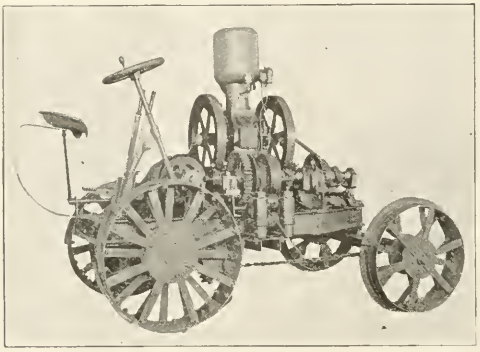
The device consists of but two elements: First, a pendulum mass which will swing from side to side in response to the side-sway of the moving vehicle, and second, a chart rotating at clock speed, upon which the pendulum marks a record which indicates that side-sway, and hence travel is going on. Of course, the absence of this record shows that the vehicle is standing. The pendulum records its oscillation on the chart by means of a stylus that is set in the pendulum near its point of suspension.

Trench Backfiller of Drag-Line Type

The trench backfiller here illustrated, of Pawling & Harnischfeger manufacture, is of the drag line excavator type and is designed to backfill all ditches ordinarily cut with trench excavators for water, gas or sewers. This backfiller has established a reputation for dependability and economical performance.

The car body is built up of two 6-in. channels running the length of the unit and cross-connected by means of 6-in. channels where necessary. The machinery base, consisting of two 6-in. channels, is mounted on top of these beams. The main machinery consists of one intermediate shaft, chain connected to the engine, and one drum shaft, gear connected to the intermediate shaft..

The drum runs loose upon the shaft and is connected to it by means of a cone clutch lined with asbestos lining. The drum is 7-in. in diameter for ⅜-in. steel rope. The intermediate shaft is connected to the engine by means of a high-speed roller chain of 1-in. pitch. A cone clutch is provided on the intermediate shaft, enabling all machinery to be placed out of action. A steel bevel pinion on the end of the intermediate shaft is provided with two semi-



POWER BACKFILLER FOR FILLING MACHINE-CUT TRENCHES.

steel bevel gears on the propelling shaft. These gears are provided with clutches, by means of which propelling motion is obtained in either direction. The propelling speed is approximately 1½ miles per hour.

The steering machinery is mounted under the car body and is operated by a worm and worm wheel, which is self-locking. Connection between this shaft and the front axle is by means of chains. The steering shaft is hand operated, a large hand wheel, with handle being provided for this purpose.

The operating levers are located at the rear of the machine and are so grouped that they can all be reached from one position.

A scraper 4 ft. wide, of Fresno type, is furnished with the machine.

The machine is driven by a 6-H.P., single cylinder vertical, hopper cooled engine running at 450 revolutions per minute, and connected to the machinery by means of a high-speed roller chain. The fuel tank is located in the base of the engine, pump being provided to deliver the fuel to the mixer. The engine is provided with an efficient governor for regulating its speed.

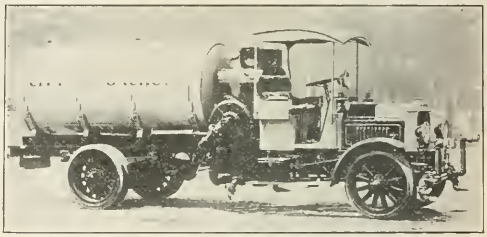
The major dimensions of the backfiller are: Out to out of rear wheels, 5 ft.; wheel base, 6 ft.; weight, in working order, about 4,000 lbs.

Combination Motor Flusher and Sprinkler for Jackson, Michigan

The city of Jackson, Mich., is now equipped with the type of motor truck flushing and sprinkling apparatus here illustrated. It is believed to be the first combination flusher and sprinkler. This is a 3½-ton Federal truck with flusher and sprinkler equipment.

Heretofore Jackson has operated two or three horse drawn sprinkling wagons capable of covering about two city blocks at one filling. The cleaning of pavements has been done entirely with sweepers. Now, with this new type of combination power flusher and sprinkler, the dirt will be literally blown off the street with the four flushing nozzles, which have a water pressure of 40 to 60 lbs., giving sufficient force to flush a 40-ft. street, while the two sprinkling nozzles can cover an 80-ft. street.

The water is carried in a 1,000-gal. tank with an independent power plant, a four cylinder motor mounted behind driver's seat ahead of the tank. This is the only unit of its kind built so far with a starter on the auxiliary engine. With this type of extra power plant the truck motor is not robbed of driving power and a steady pressure is at all times main-



FEDERAL 3½ TON TRUCK WITH FLUSHER AND SPRINKLER EQUIPMENT, AS OPERATED AT JACKSON, MICH., WHERE IT SUPERCEDES THREE SPRINKLING WAGONS AND SWEEPERS.

tained for flushing purposes. Pressure can be instantly regulated from the driver's seat to insure proper radius or spread of stream.

The pump driven by the auxiliary engine is a single stage centrifugal direct connected to the engine by a universal joint and has a 3-in. suction and a 2½-in. discharge nozzle.

The truck is equipped with generator and storage battery and four electric lights permit sufficient night street cleaning. Two big headlights, a tail light and a large search light furnish a splendid light for this purpose.

Applications of the Dravo Whirler

Shipyard requirements have acquainted builders with the tower whirler made by the Dravo Contracting Company, Pittsburgh, Pa. These whirlers can be erected quickly, and work fast and continuously in handling heavy material. The tower whirler consists of a standard Dravo whirler, mounted on a movable tower from 40 to 60 ft. high. The whirler carries a boom from 50 to 65 ft. long, and turns through a full circle in approximately a half minute. At its extreme working radius it will lift a 10-ton load.

The tower is mounted on four wheels and travels at the rate of about 200 ft. per minute along a 20-ft. gage track. Locomotives and cars can pass beneath the tower. Towers are usually constructed of timber, on account of the steel shortage and to facilitate ease of installation. The operator is 40 ft. or more above the ground, where he can watch the load constantly, without reliance on signals.

Tower whirlers are built either for electric or steam drive. When electrically operated, the usual voltage is 230 direct current, taken from three rails well protected by wood boxing. Hoisting and swinging motors are in the whirler cab, while the traveling motor is located on a platform about half way up the tower. When steam is the motive power, the hoisting, swinging and traveling drums are in the cab, as well as the boiler. Either coal or oil is used as fuel. Tower whirlers are being installed in public yards that do nothing but outfit ships built elsewhere. They are also being used in marine and rail-

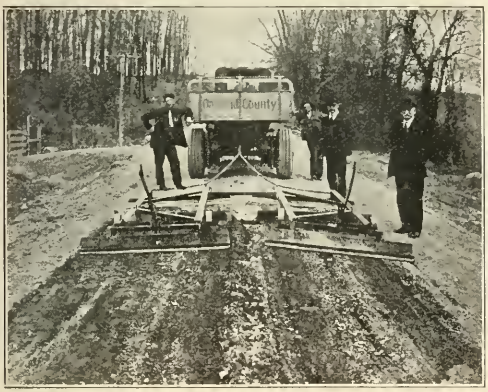
VIEW OF THE DRAVO WHIRLER.

way terminal work for the rapid handling of material on and off ships. These whirlers are widely used by sand and gravel contractors on account of their speed and large area of operation, and by general contractors in a wide variety of work. They are used by railroads and large industrial plants for coal handling and storage yard material handling.

A Line of Single and Double Road Planes

The double road plane manufactured by Angus McCallum, Pontiac, Mich., is here illustrated. This plane is designed for the care and maintenance of gravel and dirt roads. It can be adjusted by the lever which deflects the rear blade and controls the depth of the cutting blade in the center. This eliminates waves and depressions in the road service and facilitates drainage. The plane is 10 ft. long, 5 ft. wide, weighs 400 lbs., and can be drawn by two horses, motor truck or tractor.

The double plane takes a width or road of from 9 to 12 ft., working road material toward the center and filling depressions. It is claimed that two men with truck or tractor will cover 20 miles and more per day in crowning earth or gravel

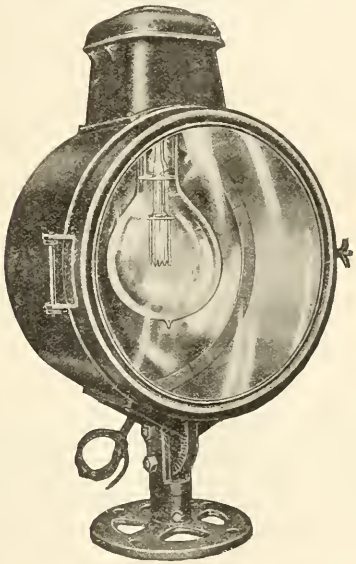


McCALLUM DOUBLE ROAD PLANE IN OPERATION, OAKLAND COUNTY, MICH.

roads with this plane. The single plane covers a width of 5 ft. at a time; a third plane is for use on roads from 12 to 20 ft. wide and consists of a double plane with cutting blades both angling the same way, which goes up one side of the road and back the other. The weight of the entire machine is on the cutting blade until the end blades strike and this accounts for the great cutting capacity on hard surfaces. The county road commissioners of Oakland county, Michigan—John A. Adams, Leonard, Mich., chairman, have 49 of these planes in use.

A New Flood Lighting Projector

A new flood lighting projector, designed for short range work where wide dispersion of beam, with relatively small concentration of light is desired, is here illustrated. This is the type FL-1419 Flood Lighting Projector, manufactured and marketed by the Electric Service Supplies Company of Philadelphia. These projectors are equipped with 14 in. long focus type parabolic reflectors, which are supported in steel, felt-lined shells, securely held throughout the entire periphery.



FLOOD LIGHTING PROJECTOR FOR SHORT RANGE WORK.

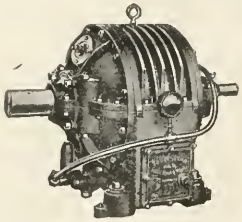
These projectors are adapted to use standard type 750 to 1,500 watt Mazda C (or nitrogen filled) lamps, and are equipped with standard Mogul sockets, arranged with a universal focusing device, by which the filament of the lamp may be brought to the focal center of the reflector and securely locked.

The projector illustrated has a maximum height of 29½ ins., maximum depth of 14¾ ins., and a maximum width of 18 ins., and weighs 54 lbs. Projectors of this type are very efficient in lighting night work in industrial and construction operations.

The Turbo-Gear and Its Application to Turbine-Driven Centrifugal Pumps

In connecting centrifugal pumps or other apparatus to the driving unit some form of speed transforming equipment is necessary. This is because the power unit requires a greater or less speed than the driven unit. There is, therefore, a demand for a speed increaser or decreaser which is efficient, occupies small floor space, is unaffected by dirt or moisture and that requires a minimum of attention and ad-

justment after installation. It is claimed for the reduction gear, here illustrated, that it meets all these requirements. It is called the Turbo-Gear and is manufactured by the Poole Engineering Company of Baltimore, Maryland.



TURBO-GEAR SPEED REDUCER.

The Turbo-Gear differs from other reduction gears in that there are no over-hung shafts or gears, all shafts and gear members being supported on each side—thus insuring permanent alignment. The Turbo-Gear operates without noise or vibration. It will drive in either direction of rotation without making any changes in it. It is light in weight. It can be furnished in any ratio from 4 to 1 up, and in any capacity from 1 to 20,000 H.P.

An example of the application of the Turbo-Gear to a pump drive is as follows: An 85 H.P. gear direct-connected to a General Electric turbine running at 3000 R. P. M., and driving a C. H. Wheeler centrifugal pump at 870 R. P. M.

New Expansion Coupling for Connecting Water Meters Into Straight Line Pipes

To meet the demand for an efficient expansion coupling, E. H. Ford, of the Ford Meter Box Company, Wabash, Ind., has designed a fitting which will be of interest to the water works fraternity and the plumbing trade.

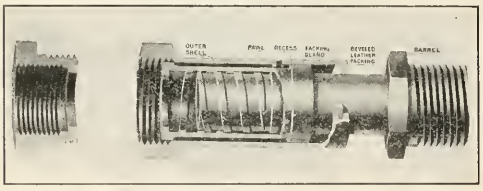


FIG. 1—CROSS-SECTION OF NEW FORD EXPANSION COUPLING.

This coupling, while designed primarily for the purpose of connecting water meters into straight line pipes, may be and 1-in. meters and may be used in connection with ½, ¾

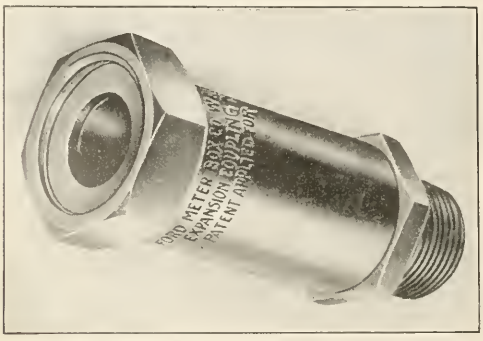


FIG. 2—FORD EXPANSION COUPLING CONTRACTED.

used in any place where flexibility is required in water, gas or steam piping. It is made now in three sizes, for ⅝, ¾ and 1-in. pipe. No special tools are required for its installation.

This coupling is shown clearly in cross section in Fig. 1, and its simplicity is apparent. It is composed of only three parts and the three sizes mentioned provide expansion range

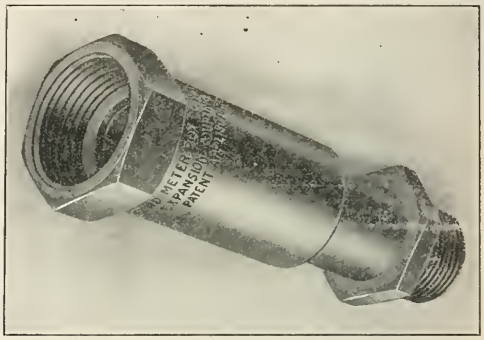


FIG. 3—FORD EXPANSION COUPLING EXPANDED.

of ⅝, ⅞ and 1-in. respectively. Sample couplings have been subjected to test pressure of 300 lbs. without showing leak. Figs. 2 and 3 show external views of coupling both expanded and contracted.

The Ford Meter Box Company is now placing these couplings in production and expects soon to have them on the market.

Equipment for Heating and Distributing Bituminous Road Material

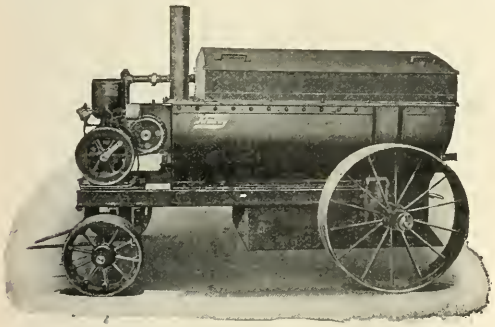
The equipment here illustrated and described is made by the Kinney Manufacturing Company, Boston, Mass., for heating and distributing bituminous road material for maintenance and repairs of roads and highways.

The heater and distributor are furnished in both automobile and horse-drawn types, using the Kinney rotating plunger pump for furnishing pressure. An improved system of heating and circulation insures heating efficiency, with no danger

THE KINNEY HEATER AND DISTRIBUTOR AS OPERATED IN PROVIDENCE, R. I.

from overheating. The distributor is also furnished in a special type of construction adapted for handling heavier materials when used in barrels instead of tank cars. In this machine the heat is derived from wood, coke or coal fires in a

similar manner to that in familiar makes of tar kettles. It may also be equipped with the Kinney heating and circulating system, the same as in the auto or horse-drawn distributors mentioned. This apparatus is of especial advantage in the work of maintenance or for more limited construction work. In the handling of all kinds of heavier grades of bituminous materials, requiring to be heated to a high temperature, especial care should be taken that no moisture be allowed to come in contact with the material in the process of heating. A slight amount of water will cause the material to froth or foam and become less valuable for road work. This possibility is always present when steam is used for heating. In all types of the Kinney apparatus no steam is used, the heat being derived direct from the Kinney kerosene oil burners in the automobile and horse-drawn types of apparatus and from wood or coal fires or kerosene heaters in the "Handy" heater and



THE KINNEY HANDY HEATER AND SPRAYER.

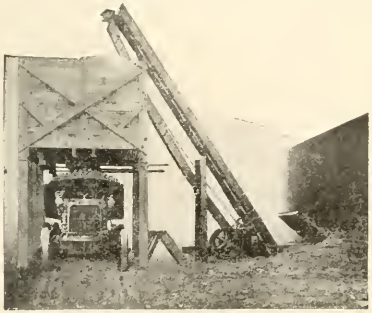
distributor. In the automobile and horse-drawn types of apparatus the heat from the kerosene oil burners is conveyed through tubes placed in the interior of the tank. This, together with the Kinney circulating system, eliminates, it is claimed, all possibility of danger from introduction of moisture, and also from burning or overheating.

In the heater and distributor the side control of the spray is so arranged as to swing the distributing pipes and nozzles 2 ft. on either side, so as to insure perfect contact of the successive applications without overlapping or leaving bare spots on the road. The circulating device is, in effect, an agitator, and produces a uniform temperature throughout the contents of the tank and hastens the process of heating. The control is so positive that the dripping of oil on cross-walks is easily prevented. An open connection is provided for the attachment of a hose and nozzle for hand spraying or patching under pressure.

The "Handy" heater and sprayer is furnished with power or hand-driven Kinney pump. It has a welded steel tank and is self-loading from heating kettles or tank cars. The pump and spraying hose are always hot and cannot become clogged. Suitable strainers prevent obstruction of pipes and spray nozzles.

A Continuous Operating Car Unloader

A strictly one-man machine of improved design is the Panama continuous operating car unloader, made by the F. B. Zieg Manufacturing Company, Fredericktown, Ohio. The unloader consists essentially of a steel box which is placed under the track. This has an eccentric driven movable bottom, which operates with a shaking motion, and delivers the material to the buckets which carry it up and into the bin. To install the box it is necessary to excavate a hole 2 ft. wide, 1 ft. deep and 8 ft. 6 ins. long. The unloader measures 6 ft. x 7 ft. It is claimed that this unloader will completely empty a gondola car of limestone in from 40 to 60 minutes, at a cost of approximately 1c per cubic yard, which is about one-tenth to one-fifteenth of the cost of unloading by hand. It will handle sand or limestone screenings as efficiently as crushed stone,



THE ZIEG CONTINUOUS OPERATING CAR UNLOADER.

whether the material is wet or dry. The conveyor frame is made in two parts and may be shortened, if desired, to make an outfit for loading directly into wagons. Wagons are driven directly under the bin, so that they load full and evenly. The outfit consists of the unloader complete with heavily constructed bin of one-half or one-car capacity, and a 6-h.p. gasoline engine of improved design.

Personal Items

C. A. Jennings, manager of the Chicago office of Wallace & Tiernan Co., has been commissioned captain in the Quartermaster Corps, Maintenance and Repair Branch, Construction Division, United States Army, with headquarters at Washington, D. C. Mr. Jennings was superintendent of the famous Bubbly Creek Filtration Plant at the Chicago stock yards from its inception in 1908 until two years ago. His work at Washington will be under Major George A. Johnson, and he will look after water supplies and sewerage systems at the various cantonments.

L. H. Goebel has resigned as Superintendent of Filtration and Chief Chemist of the Water Filtration Plant of the Union Stock Yard and Transit Company, Chicago, Ill., to become associated with the engineering staff of Wallace & Tiernan Company, manufacturers of chlorine control apparatus and sanitary engineering specialties. After graduation in Sanitary Engineering at Purdue University, Mr. Goebel was attached for a time to the Union Stock Yards filtration plant and subsequently was Sanitary Engineer, City Chemist, and Bacteriologist of Cedar Rapids, Iowa, returning to the Union Stock Yards Company early in the present year. Mr. Goebel will be attached to the Chicago office of Wallace & Tiernan Company.

Augustus Hunt has been appointed City Engineer of Crookston, Minn. Mr. Hunt was engaged in engineering work on the Valier-Montana Irrigation Project in 1911, on the Coon Rapids Dam at Anoka, Minn., in 1912 and for the past five years has been Assistant City Engineer of Minot, N. D.

W. A. Fuller and A. H. Beard announce the formation of the firm of Fuller & Beard, Engineers, Chemical Building, St. Louis, Mo. W. A. Fuller, formerly of the Fuller-Coult Com-

pany, after having acquired Mr. Coult's interest in the company's engineering business last year, was called East to take charge of the designing of the water supply, fire protection, sewer system and sewage disposal, as sanitary engineer for the United States Shipping Board, Emergency Fleet Corporation, at Hog Island, Pa., the largest shipbuilding plant in the world, has completed the work for the government and has returned to St. Louis. A. H. Beard was with the American Water Works and Guarantee Company, of Pittsburgh, Pa., from 1905 to 1908, as constructing engineer on the construction of their water filtration plants at South Pittsburgh, Pa., Suffolk, Va., Chattanooga, Tenn., and St. Joseph, Mo., and for the past ten years has been superintendent of construction for the Pennsylvania Department of Health in charge of all construction at the State Sanitoria at Mont Alto, Cresson and Hamburg, Pa., including water works and sewage disposal.

F. L. STOCKBERGER, superintendent of the municipally owned garbage and reduction plant at Cleveland, has resigned to enter another line of work. He is succeeded by Chas. C. Smith, until recently connected with the municipal lighting plant, and who was assistant superintendent of the garbage plant several years ago.

Norman P. Gerhard, for 10 years assistant engineer, Board of Water Supply of the city of New York, recently accepted a position as resident engineer on work at Cumberland, Md., for Jas. H. Fuertes, consulting engineer, New York City.

C. E. Tilton has been appointed city engineer of Phillipsburg, N. J.

R. H. Wiedman has been appointed city engineer and water commissioner at Whitefish, Mont.

Leroy C. Smith, who for several years was deputy state highway commissioner of Michigan under Frank Rogers, with headquarters at Lansing, has been appointed chief engineer of the Wayne County, Mich., Road Commission.

CATALOG REVIEWS

Truscon Building Products Booklet; issued by Truscon Steel Company, Youngstown, Ohio; 104 pages; 3½ x 6 ins. This is a new edition of this popular, useful and convenient little publication, issued for architects and builders. The small size is such that the booklet can be conveniently slipped into the pocket. The booklet contains a great fund of useful tables and information for architects and builders. It is a digest of the numerous elaborate catalogs published by this company. It contains complete information on the various Truscon products, tables of carrying capacities, strengths, etc. This is the eighth edition, and has been completely revised to bring it up to date. The products given special attention are: Reinforcing steel, Floretyles, Hy-Rib and metal lath, pressed steel joists and studs, highway reinforcements, curb bars, concrete inserts, steel windows, steel buildings, hollow tile, chemical products, etc.

Concrete Mixer—Issued by the F. C. Austin Company, Ind., Chicago, 84 pages; 8 x 11 ins. Relates to the Austin Cube Concrete Mixer. Illustrates and describes this type of mixer very completely in all its various mountings. The various component parts of the mixer are illustrated and described, and their special uses enumerated. Many illustrations are shown of mixers of this type as operated on important construction jobs throughout the country. Gives specifications for mixers of different sizes and types. Gives operating records. The Austin Paver is especially well illustrated and described, with specific information on the utility of concrete roads. Data also given on the construction and maintenance of concrete roads.

Road Building Machinery—Issued by Port Huron Engine and Thresher Co., Port Huron, Mich.; 24 pages; 8 x 11 ins. Illustrates and describes the line of road building machinery manufactured by this company, including rollers, dump wagons, scarifiers, dump cars, road sprinklers and engine tenders.

Rex Record—Issued by the Chain Belt Company, Milwaukee, Wis.; 16 pages; 8½ x 11 ins. Volume 1, No. 1, issue of the Rex Record, the house organ of the Chain Belt Company, dated June, 1918.

Sewer Cleaning Equipment—Issued by the Turbine Sewer Machine Company, Milwaukee, Wis.; 48 pages; 7 x 10 ins. Illustrates and describes the sewer cleaning equipment manufactured by this company, with special reference to the Turbine Sewer machine, the Turbine windlass, the Turbine forcing jack, iron and wood sewer rods and telescoping sewer braces. Gives many testimonial letters showing the value of the Turbine sewer machine, and shows many illustrations of accumulations of foreign materials removed from pipe sewers by means of this machine. Operation of the cleaning equipment fully illustrated and described.

Mixer Loader—Issued by the Koehring Machine Company, Milwaukee, Wis.; 4 pages; 8½ x 11 ins. Fully illustrates and describes the essential features of the construction and operation of the Koehring concrete mixer loader. Gives specifications for the loader also.

Squeegees and Sand Spreaders—Issued by The Kindling Machinery Co., Milwaukee, Wis.; 44 pages; 6 x 9 ins. Gives report of New York tests on street washing machines, and report of the operations of the street cleaning division at the Engineering Department, District of Columbia, Washington. Fully illustrates and describes the company's new motor-driven squeegee for cleaning large areas of smooth pavement. Also illustrates and describes the sand spreader.

Sand Tester—Issued by Kolesch & Company, 138 Fulton St., New York; 12 pages; 4 x 9 ins. Fully illustrates and describes the construction and operation of the Universal Sand Tester, by which anyone can make accurate sand analysis.

Tarvia-A—Issued by the Barrett Co., of New York; 3½ x 6 ins; 16 pages. Pertains to the use of Tarvia-A as a road preservative and dust preventive. Illustrates several roads of this class. Describes the methods of construction employed on these roads in detail. Gives bibliography on other booklets relating to Tarvia. Also by the Barrett Co., a pamphlet entitled, "The Avenue of Sublime Peace;" 6x9 ins., 16 pages. Illustrates and describes the first modern highway in China's Forbidden City. This is a Tarvia road; also illustrates Tarvia roads in the Hawaiian and Philippine Islands.

Trade Notes

The Pittsburgh Testing Laboratory has turned over its building and equipment at Seventh and Bedford avenues, Pittsburgh, Pa., to the United States government for the duration of the war. From April 1 until about June 15 its offices will be in the B. F. Jones Law Building, Fourth avenue and Ross street. After June 15 the offices and laboratories will be located at 612 to 620 Grant street, the building being remodelled and fully equipped for its special needs.

The plant of the Warner Manufacturing Co., Beloit, Wis., has been busy for the last three months executing a government contract for heavy-duty Warner trailers. Shipment overseas is now being made. These trailers are intended for use in the motor ammunition trains in France. They are a standard type Warner, four-wheel model. The regular Warner specifications are used throughout, except that the army has ordered U. S. standard pintle-eye in place of the famous Warner ball and socket hitch.

EDITORIALS

Report 1919 Road and Street Projects Now or Never

The necessity of making the prescribed reports at this time on all road and street work contemplated for the year 1919 cannot be over-emphasized. The matter is one of paramount importance. It is vital.

On September 21st the United States Highways Council wrote to the State Highway Departments, stating that full information on all projects for the construction, reconstruction, maintenance and resurfacing of highways, proposed to be done in each state in 1919 must be assembled and transmitted to the proper state highway department by state, county, city and township officials for the immediate approval of such state highway department. Each state highway department is then required to transmit all approved projects to the United States Highways Council for its approval on or before Dec. 10, 1918.

Upon the projects that are thus assembled and transmitted to the State Highway Departments depends all the work that will be done on roads and streets in 1919. Consequently, lining up this work and immediately reporting it to the several state highway departments is important in the very last degree.

The State Highway Departments were requested in the letter of September 21st, from the United States Highways Council, to send out suitable forms to subdivisions in their states on which reports are to be made. If there should be delay in receipt of such forms by local officials, or if for any other cause officials of subdivisions should not receive the necessary forms, important work which might otherwise be done next year would fail to receive consideration because reported too late. A contributor to this issue has, therefore, compiled a form of report which we offer for use, and which we believe will meet fully the requirements of the situation.

It will, of course, be appreciated that it is not the wish of our contributor, or of the editor, to assume the functions of State Highway Departments, but the United States Highways Council has requested the cooperation of workers in the highway field. We believe that the form and the motive prompting its publication will meet with general approval.

There is no time to be lost in filling in this, or the official, form, and mailing it to the proper State Highway Department. Procrastination in this matter will be fatal to road and street improvement work next year. Local authorities should act without delay. Highway restrictions may be removed by spring, but it would be folly to rely on this possibility.

Stimulate Local Authorities to Prepare for Peace

One hesitates to predict the early ending of the war for fear of becoming a prophet after the fact. During the time that must elapse between writing and mailing an issue of any periodical the end of the war may come. It is the concensus, however, that the end is not far off and that view is sufficiently conservative. While there must be no relaxing in our war efforts as long as the war lasts, developments in recent weeks clearly indicate the wisdom of preparing now for peace.

When the war ends the men under arms in this country will soon be demobilized. The return of the men overseas will begin, but these men will not come back as fast as they went over and it will probably be fully a year or a year and a half after peace is dictated before the last Yank leaves France. But the millions of men who are now engaged in war industries will be laid off with amazing rapidity when the government begins wiring its cancellations of war orders. Men by the tens and hundreds of thousands will be discharged in great groups by printed notices tacked on the factory gate. What shall be done with these idle men?

Unless cities and counties have public works projects ready for launching to occupy these men no longer wanted in the munitions factories, we are in for a tough time of it, all the way from the soup kitchen and bread line to the jail. City and county officials should now be clearing away all preliminaries, placing themselves in readiness to employ these men on construction as soon as the end of the war releases them. Much valuable time has already been lost; there is no more to lose.

It is to be hoped that every city engineer, every county engineer, every consulting engineer, and every engineering publication will steadily exert all possible influence on local authorities to the end that plans, plebiscites and palavers shall be finished off now so that construction can begin with the ending of the war.

Cleveland Sets Good Example to Other Cities in Preparing for Peace

While thousands of the young men of Cleveland are in the military service and tens of thousands of Cleveland men are engaged in war industries, the city officials are planning a great public works program which will provide employment for all these men when the end of the war comes. Mayor Davis has formulated a $20,000,000 program of post-war improvements in addition to the subway plan which calls for another $10,000,000. The wisdom of this course should appeal to other mayors, of cities of all sizes. As our farseeing fellow-citizen Theodore Roosevelt has on several occasions pointed out, nine-tenths of wisdom is being wise in time. Mayor Davis is wise in time.

We publish in this issue an article giving the outstanding features of the Cleveland program. The comprehensive character of the program is especially commendable. It comprises: water works improvements to cost $10,000,000, including a filtration plant, reservoir, pumping station, and new mains; light and heat extension work amounting to $3,000,000; a $300,000 park bath house and a park recreation pier; a farmers' wholesale market and warehouse with railway terminal facilities, to cost in all $750,000; several public bath houses and swimming pools; stream improvement

work; hundreds of miles of paving and sewering already approved by the voters; new traffic lanes to relieve congestion; garbage collection stations; and numerous public buildings for a variety of uses, such as police and fire stations, comfort stations, etc.

The mayor's well-rounded program is based on reports prepared for this purpose by the heads of the several departments of the city government.

Mayors of other cities must formulate suitable programs, as Mayor Davis has done, or demonstrate by their inaction that their lack of ordinary foresight entirely unfits them for holding a responsible position in times like these. It is the clear duty of the engineer advisers of mayors to labor with these chief executives of cities to the end that preparation be made now for safeguarding industrial and economic conditions at the end of the war period.

It is not enough that the engineer be merely a dutiful servant; he must assert himself. He must try to convince his non-technical superiors of the imperative importance of lining up construction projects now, and if unsuccessful in this effort he should not hesitate to appeal to the people, directly or indirectly. He will find that the commercial organizations, public spirited organizations of all sorts, and the newspapers of his city will co-operate with him. Let him provide the data for a campaign and these other agencies will conduct it to an early and successful conclusion.

As public sentiment crystallizes and gains momentum, officials with an early disposition to obstruct will perceive the expediency, if they do not see the wisdom, of getting in front of the movement. Any politician prefers leading a movement to being steam-rollered by it. The engineer has the knowledge and, we trust, the courage to put the steam-roller in motion.

Highway Transportation is Getting Recognition in High Places

Not with the grand air of Balboa discovering the Pacific Ocean, but with the humble attitude of big men who know much and want to learn more, various important federal officials are beginning to take cognizance of highway transportation. They appreciate the fact that the logic of events has forced the partial development of this class of transportation, and this in spite of all manner of handicaps and restrictions. The economic soundness of the claims advanced for highway transportation has been established. All the efforts put forth in recent months to convert federal officials to a belief in the value of good roads as a part of the nation's transportation system, are now definitely justified and are on the eve of becoming fruitful.

To stimulate to greater efforts those who have been working for months in the interest of highway transportation, as well as to arouse to like activity those who have been content with suspended animation, we are publishing in this issue addresses recently delivered by Secretaries Redfield and Lane, of the President's cabinet, and by United States Senator Chamberlain, who comes from Oregon, by chance, but ably represents the entire country, by choice. These officials speak understandingly of the value of good roads as a means of developing the highway transportation we must have before our general transportation system can be regarded as at all complete and adequate.

Senator Chamberlain concluded his remarks by expressing the opinion that Congress will act as soon as it is well informed in the premises. This is encouraging, indeed, and should prompt those who understand the problem, and the needs of the situation, to write as many informative letters as may be necessary to their representatives in Congress. It is suggested that all Senators and Representatives be urged to vote for the creation of a federal highway commission that will handle the highway problem as vigorously as the Emergency Fleet Corporation has handled the shipping problem. This is the measure advocated by all those who have given the matter close study and may safely be adopted by all others.

Every reader of this publication should write to his representatives at Washington, urging the immediate creation of a federal highway commission with a personnel fully informed on the economics of highway transportation. The pioneering has been done, but the matter has not been settled. Now is the time for every man who believes in the military and commercial value of hard-surfaced roads to act. Certain officials have shown that they are now receptive and others will become so under the pressure of opinion from home and in the stress of the situation produced by the annual falldown of the railroads which impends.

To Lower the Cost of Living

It will not be disputed that Herbert Hoover knows as much as anybody else about the production, marketing and cost of food in the United States. Consequently, when Mr. Hoover advocates the building of dependable highways to encourage greater production of food and to make possible the decreased cost of food through the operation of the rural motor express, his views carry great weight. He is interested only in more food at less cost and is free from any charge of bias. He speaks for the public and not for any private interest.

We have before remarked that next to winning the war the thing most desired by the American people is to see the cost of living reduced. Fortunately, responsible public officials are now beginning to realize that the fault lies partly with the narrow and restricted transportation facilities offered by the railroads. It is coming to be appreciated that with the development of a comprehensive system of national highways, with proper local feeders, idle acres will be placed under cultivation, intensive farming will be practiced where slip-shod farming has been the rule and production of food will be greatly increased; that motor trucks operating over these roads will penetrate to loading stations accessible to every farmer and will not only haul the food to cities but will take it direct to great public markets, or direct to the neighborhood grocer, thus cutting out several middlemen with their exorbitant profits, and their manipulation, hoarding and speculation in the first essential of life.

Clearly this plan is in the interest of the producer, the consumer and that worthy and useful citizen, the small retailer. The only ones to suffer from the development of this plan will be the food speculators and the public is not very tender of the feelings and welfare of these food cormorants who have subjected hundreds of thousands of people to slow starvation, and millions of people to penury through extortionate food prices.

Surely, nothing was ever more worthy the best efforts of the engineer, the contractor and the manufacturer than to work for and on this system of highways which will reduce the cost of living.

All 1919 Street and Highway Improvement Projects Must Be Presented for Approval by December 10, 1918

By Maurice B. Grecnough, Assistant Secretary, National Paving Brick Manufacturers' Association, Cleveland, Ohio

A letter of great importance to all interested in highway improvement in 1919 was addressed to state highway departments on Sept. 21, 1918, by the United States Highways Council. State highway departments are directed therein to secure a complete schedule of all projects of road and street construction, reconstruction, maintenance and resurfacing in states, counties, cities and townships, proposed to be done in 1919; projects will be reviewed by state highway departments and all approved by them will be transmitted to the United States Highways Council for its consideration on or before Dec. 10, 1918.

Quick Action is Imperative

This is tantamount to saying that unless proposed work for 1919 is thus assembled for approval by state departments and by the council, it can not proceed next year. The time is short; engineers and officials and the public which has an interest in any project contemplated, should co-operate freely and without delay in order that none may be overlooked or fail of the necessary consideration.

Each state highway department is requested by the council to prepare proper forms for transmission to county, city and township officials, upon which are to be reported the required data. Wherever possible, maps should accompany and be a part of the data submitted in order to show the relation of the proposed projects to other highways or parts of highways improved or proposed to be improved.

Separate schedules are required for construction, reconstruction, maintenance and resurfacing, and each of these kinds of work must be submitted to the state highway departments by each county, city and township.

A Suggested Form

In the event that officials may not receive forms and in view of the shortness of time, the following is offered to engineers and officials for their use. The information which will be supplied by filling out this form will be comprehensive and adequate to meet the situation, although any further data to support projects not comprehended herein should be filed in addition.

Projects proposed for 1919 are required to fall within the description of Bulletin 1 of the United States Highways Council; approval will be considered for (1) Highways of military importance; (2) Highways of national economic importance; (3) Unfinished construction which can not be safely postponed another year; (4) Highways of local importance of such urgency as to cause very great hardship if construction is delayed.

It is further to be noted that unfinished work must be reported for approval so that it may be approved and allowed to proceed.

These reports should be placed in the hands of state highway departments at the earliest possible moment in order that no 1919 projects may fail through lack of time for adequate consideration.

The Form

State of.....
County of.....
Date.....1918.

Proposed highway construction during calendar year 1919.

Attached hereto is listed the following described (highway) (street) which in the judgment of the constituted authorities of this (county), (city), (township) is so vitally essential as to call for (construction), (reconstruction), (maintenance), (resurfacing) during the year 1919.

This highway is selected for the following reasons:

1st. Military importance.

2nd. National economic importance.

3rd. Unfinished construction which can not be safely postponed another year.

4th. Local importance of such urgency as to cause very great hardship if construction is delayed.

We pray, therefore, for its approval by the State Highway Department and the United States Highways Council.

(Signature of Officials)

_____

_____

_____

I. Location of proposed improvement:
- (a) State of .....
- (b) County .....
- (c) City or town .....
- (d) Name of street or road.....
- (e) To be improved from..... to .....
- (f) Length ..... miles; Width..... ft.

II. To be improved by:
- (1) Construction.
- (2) Reconstruction.
- (3) Maintenance.
- (4) Resurfacing.

(Indicate work to be done by cross—X.)

III. Probable type: .....

IV. To be improved by:
- (a) State..... (b) County..... (c)City.....
- (d) Township..... (e) Road district.....
- (f) Federal government .....

(If improvement is a joint one, check all who will supply funds.)

V. Estimated cost of proposed improvements: $.....
- (a) To be paid by state, per cent., ... Amt., $....
- (b) To be paid by county, per ct., ... Amt., $....
- (c) To be paid by city, per cent., ... Amt., $....
- (d) To be paid by t'nship, per ct., ... Amt., $....
- (e) To be paid by federal government, per cent., ... Amt., ...
- (f) To be paid by abutting property owners, per cent., ... Amt., $....

(State above the per cent. or amount, and both if possible.)

VI. Sources of funds for proposed improvements:
- (a) Current taxation, Amt., $.....
- (b) Sale of bonds, Amt., $.....
- (c) From abutting property, Amt., $.....
- (d) Appropriated from funds in hand, Amt., $.....

VII. Status of funds:
- (a) On hand or to be on hand from current funds, $.....
- (b) Bonds voted but not approved by the Capital Issues Committee, $.....
- (c) Bonds voted and approved by the Capital Issues Committee, $.....
- (d) Bonds not yet voted, $.....

VIII. Kinds and amounts of materials required and source:
- (a) Kind..... Local, Shipped, Amt.....
- (b) Kind..... Local, Shipped, Amt.....
- (c) Kind..... Local, Shipped, Amt.....
- (d) Kind..... Local, Shipped, Amt.....

(e) Kind..... Local, Shipped, Amt.....
(f) Kind..... Local, Shipped, Amt.....
(Write the kind of materials required above and underscore the source.)

IX. Labor:
(a) Number of labor-days required, free labor.....
(b) Number of labor-days required, prison labor....

X. Transportation requirements:
(a) Number of open-top cars required.....
(b) Number of box cars required.....
(c) Per cent. moving toward the mines.....

XI. Describe fully the present traffic over the street or road. What commodities are being hauled? To what extent? What is the nature of vehicles? State the importance of the highway or street to the communities reached, and the bearing upon national requirements.

XII. Give any other information supporting this application.

The Maintenance of Asphalt Pavements by the Cut and Replace Method

By James W. Routh, Assoc. Mem. Amer. Soc. C. E., Chief Engineer Rochester Bureau of Municipal Research, Inc., Rochester, N. Y.

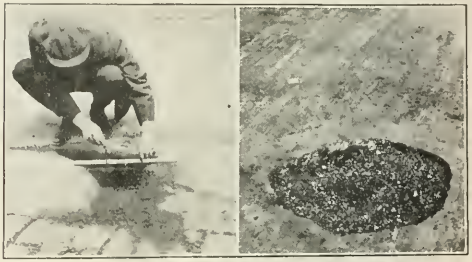
The method of making repairs to asphalt pavements which will be discussed here is that which is generally known as the cut and replace method. This method requires the removal of defective material and its replacement with fresh; it is in most general use. The surface heater method is advantageous in leveling up low spots and wavy surfaces where there has been little or no actual disintegration of the materials in the surface. Where disintegration has occurred, however, and where there are holes to be filled, the cut and replace method of making repairs is believed superior by the writer. In cities having a large mileage of asphalt pavements both methods can be used with advantage.

Plant Operation

Plant control is no less important in repair work than in original construction. The same care must be taken in the preparation of the materials if satisfactory work is to be done. The plant should be equipped so that the several ingredients of the product are proportioned by weight. This is not only necessary to obtain a uniform product, but is the most satisfactory method of determining the quantity of materials placed in the street. (Further reference to the latter point will be made later.) The plant also should be equipped so that accurate temperature control of all operations is possible. Mechanical devices, such as bucket conveyors for handling aggregates (from the cars to the plant, as well as in the plant), and pressure pumps and tanks for the bituminous materials (which then can be shipped in tank cars), will be found economical aids to plant operation.

The Mixture

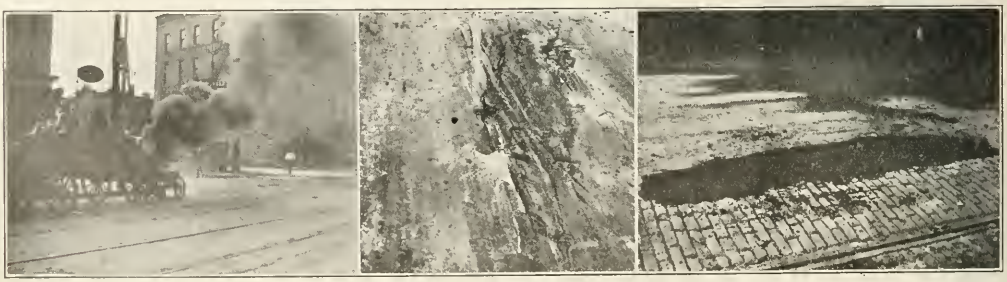
The kind of mixture used in repair work should not differ materially from that used in the original construction of the pavement. It is not believed, however, that specifications which call for the use of a mixture in repairs identical with that used in the original construction are necessary or fair to the plant operator. An average mixture should prove satisfactory in all cases. And where a stone-filled asphalt wearing surface is repaired an all-sand mixture generally will be found more satisfactory for making the repairs than a stone-filled mixture, since with the latter it is difficult to obtain tight, smooth joints.



VIEWS ILLUSTRATING POINTS IN ASPHALT MAINTENANCE.
Left: It is Poor Policy to Leave Low Spots Between Patches. All Defective Material Should be Replaced—Right: The Vertical Edges of Holes Should be Thoroughly Coated with Tar or Pitch.

Inspection

A competent inspector should be placed in charge of each asphalt plant in operation. Preferably, this man should be attached to the staff of the testing laboratory which directs the preparation and use of the materials. He should be required to check and keep a record of the proportions of ingredients in each batch of materials mixed; to keep a temperature record of the plant operation and see that each of the ingredients of the product is brought to and maintained at the temperature required by the specifications; to make periodical sieve analyses to check the grading of the mineral aggregate; to observe the uniform quality of the asphaltic cement; to take samples for laboratory analysis as directed by the testing laboratory; to keep a weight record of the plant output, and to see that all loaded vehicles leaving the plant are properly covered. The plant inspector also, of course, should keep in close touch with the laboratory at all times and should promptly report irregularities in the materials or varia-



SOME POINTS TO OBSERVE IN REPAIRING ASPHALT PAVEMENTS.
Left: Burning Tar Buckets Not Only Result in Cracked Tar but are a Source of Nuisance as Well—Center: When Rolling is Done Too Soon and is Not Continued Long Enough Patches are Soon Cut Up by Traffic—Right: When Two Layers of Surface Mixture are Required the Bottom Layer Should be Thoroughly Compressed Before Top Layer is Placed.

tions in the product. He should be required to be on the job at all times when the plant is in operation. A convenient form for the plant inspector's records and reports in shown herewith.

Equipment Required

In addition to the asphalt plant, the cut and replace method of making repairs requires the following equipment: motor trucks or wagons for transporting the materials from plant to street; cutting tools and picks for cutting out and removing

VIEWS ILLUSTRATING WRONG AND RIGHT METHODS OF HOLDING ASPHALT CUTTING TOOLS.

Left: Wrong Method Results in "Overcut" Edges. Right: Right Method Results in Slightly "Undercut" Edges.

defective spots in pavements; brooms and shovels for cleaning out the cut holes; shovels for handling the hot asphaltic materials; long tined rakes for pulling over and shaping the materials in the holes; smoothing irons and hand tamps; tar buckets; means for heating tools and tar buckets, and self-propelled and hand rollers for use in compressing and finishing the patches. This equipment is so well standardized as to require no comment.

Work on the Street

For ordinary contract work, where the repair gang is divided into two parts, the cutters and the hot gang, it is believed necessary that there be two street inspectors with each gang. The duty of one man should be to mark out the work in advance and to supervise the work of the cutters. The other man should be in charge of the hot gang, to keep track of temperatures and the placing and rolling of the materials.

Temperature

The asphaltic materials should be hauled to the street in covered vehicles regardless of the season of the year or temperature of the air. The covering of the materials in transit is necessary to prevent irregularities in cooling as well as excessive cooling. Immediately on delivery at the street the inspector should take the temperature and make certain that it falls within the specified limits.

Marking

In making repairs on a street it is best to remove all defective spots and to make all of the repairs necessary at one and the same time. The inspector responsible for marking out the work should go carefully over the street in advance of the cutting gang and should mark out each area to be replaced, using red or white lumber crayon (inserted in the end of a 3-ft. marking cane) for the purpose. In marking out patches a line should be drawn around spots to be removed and far enough back to insure that all defective material will be cut out. The use of curved lines and irregular patches should be avoided. As much as possible, patches should be rectangular or circular in shape, as these simple outlines make for better jointing and easier cutting, and aid in obtaining uniform density within the patch.

Cutting

If it were possible, it would be well to prohibit the use of picks in removing defective material. The tendency of all cutters appears to be to pry up first and then cut off. This unavoidably results in loosening the surrounding surface from the binder or base. Great care should be taken in this matter, and the cutters should be required actually to cut through the material to be removed before picks are used to pry it out. (The cutting tools should be kept sharp and an adequate supply of extra tools should be required to be kept on the job). After the material is cut through, picks may be used, but the prying should be toward the inside and not toward the outside of the patch.

If smooth, tight joints are to be obtained, it is important that the edges of patches be cut as nearly vertical as possible. The ordinary tendency is to overcut the edges, which allows the fresh material to shove out of the patch and overrun the original surface. In order to avoid this, cutters should be instructed to undercut slightly the edges, since an edge sloping in this direction is preferable to one sloping in the opposite direction, for binding new material to the old. The right and wrong way of using the cutting tools is illustrated in the accompanying photographs.

Preparing the Hole

After the material has been cut out, and the large pieces removed from the area to be repaired, the hole should be thoroughly swept out with a broom and all loose dirt and water removed therefrom. If there is much variation in the depth of the patch, due to small sections of the binder course re-

Department of Public Works, Rochester, N. Y.

Asphalt weighed at plant of Load No. **1801**

DATE	BATCH NOS.	BATCH WEIGHT	LOAD WEIGHT

To be delivered on _____ St.

_____ Plant Insp.

Received and dumped on _____ St.

_____ Street Inso.

LOAD TICKET FOR CHECKING DELIVERY OF PAVING MIXTURE, DEPARTMENT OF PUBLIC WORKS, ROCHESTER, N. Y.

A White Copy of This Form is Given by the Plant Inspector to the Driver, who has it Countersigned by the Street Inspector and Turns it Over to his Superintendent. A Yellow Carbon Copy is Returned to Headquarters by the Plant Inspector.

maining attached to the concrete base, these high points should be removed, since better results are obtained if a uniform depth of new materials can be obtained. After the hole has been cleaned out, all vertical edges should be thoroughly painted with hot asphaltic pitch. This does not mean a hasty smearing of some pitch along the upper edge of the vertical surface, but a careful systematic painting of the entire contact surface. This is a detail frequently slighted. Thorough painting is necessary for proper binding of old and new materials and watertight joints.

A frequent source of trouble in repair work is the tendency of the workmen to allow tar buckets to catch fire and

burn and then to use the burned tar or pitch for painting vertical contact surfaces. Of course, such material has lost its waterproofing and cementing value and is harmful rather than beneficial. All burned material should be thrown out and not allowed to be used.

Placing Hot Material

After the hole has been properly prepared the hot surface material should be shoveled into it with hot shovels. It should be noted that in no case should asphaltic materials be allowed to be dumped from the wagon or truck into, or even partially into a hole to be filled, as this results in uneven compaction of the materials in the hole and consequent rapid deterioration under traffic. All materials should be dumped apart from the holes in which they are to be placed and shoveled into place by hand. Long-tined rakes then should be used to pull over, mix up and even up the materials in the hole. Thorough raking is essential. When this has been done, a hot hand tamp should be used to smooth around the edges of the hole before the roller is put in operation.

Tamping

Some skill is necessary in the operation of these tamps, and care should be taken that they become neither too hot nor too cold. If too hot, the tamps are liable to burn the asphaltic materials; and if too cold it is difficult to operate them without shoving and tearing the skin surface. The properly heated tamp should be dropped on the hot material at a distance of about one in. from the edge of the old surface. The tamp then should be slid over the material onto the old surface, drawing the fresh hot material tight against the joint. The operation should be continuous, and the hot tamp should never be allowed to stand on the new patch, as it is likely to burn the materials.

Filling the Hole

When the depth of a hole to be filled is more than 3 ins., it should not be filled in a single operation, because excessive thickness of bituminous materials generally results in shoving under traffic. In such cases it is best to fill the lower part of the hole with binder. If the total quantity of binder needed at one time, however, is small, it may be omitted and the surface mixture placed in two separate layers. The lower layer should be of such thickness as to leave not more than a depth of 2 ins. for the upper layer. Before the upper layer is placed the lower layer should be thoroughly compacted by hand tamping.

It is important that the finished surface of the patch conform as near as possible to the grade and contour of the remaining street surface. Patches which are higher than the surrounding pavement receive more than their share of traffic and consequently break down rapidly as well as make rough pavements. Those which are lower than the surrounding street surface also make rough pavements and have the additional disadvantage of holding water, which causes rapid disintegration of asphaltic materials. Judgment based on experience is the only guide to obtaining proper thickness of patches in repair work. The degree of compressibility varies with the character of the materials.

Rolling

If satisfactory results are to follow, it is important that the materials in the patches be neither too hot nor too cold when rolling is begun. If the materials are too cold, cracking will result. If they are too hot, shoving will result and the rolling probably will not be continued until the materials are thoroughly compacted and cooled sufficiently to bear traffic without harm. New patches cut up by vehicular traffic of one kind or another are frequently to be seen and usually result from insufficient rolling or the rolling of materials which are too hot. Thorough rolling should be insisted upon. It is believed that if proper precautions are observed as to temperature and thoroughness of rolling, a street which has been repaired may be thrown open to traffic as soon as the rolling is completed. During the course of repairs, however, the street should be completely closed off from traffic; better, quicker and more economical work will result under these conditions. It is not sufficient merely to place logs of wood alongside of the patches after the materials have been placed in them. On heavy traffic streets the entire street, or half of it at least, should be completely closed off from traffic for a block at a time until the work has been finished.

The rolling should be done preferably with two rollers of different weights. The first rolling should be done with a roller weighing about three tons, and in such case the final compression may be made with a roller weighing as much as eight tons. Good results can be obtained also by use of a single roller weighing about five tons.

Department of Public Works, Rochester, N. Y.

Plant of . Inspector Date

Kettle Mixture

Kind or Brand		Kettle No. 1			Kettle No. 2			Kettle No. 3			Kettle No. 4		
Asphalt	Flux	Asph. lbs.	Flux lbs.	Pen.	Asph. lbs.	Flux lbs.	Pen.	Asph. lbs.	Flux lbs.	Pen.	Asph. lbs.	Flux lbs.	Pen.

Screen Tests

Batch No.	Time	200		100		80		50		40		30		20		10	
		Pass	Held	Pass	Held	Pass	Held	Pass	Held	Pass	Held	Pass	Held	Pass	Held	Pass	Held

HEADINGS IN RECORD FORM FOR ASPHALT PLANT OPERATION, DEPARTMENT OF PUBLIC WORKS, ROCHESTER, NEW YORK.

	Sample Sent	No.
	Asphalt	
	Flux	
	Mixture	
	A.C.	
	Aggregate	

Basis of Payment

In general, there are two bases for payments to contractors for asphalt repair work. One basis is the superficial area of patch work actually done, which is determined by measuring up the patches before or after completion. If the measurements are taken before the patches are completed the best time is after the cutting has been completed and immediately before the hot materials are placed in the patches. If measurements are made later it is necessary that they be taken before traffic has obliterated the outlines of the patches.

Street Maintenance

Street

From To

Date		Yds Rep'd	Labor	Material

FORM OF FILE CARD FOR CHRONOLOGICAL INDEX RECORD OF REPAIRS MADE TO IMPROVED STREETS.

This basis of payment is not believed to be satisfactory. It entails an unnecessary amount of work, both in the field taking measurements and in the office computing the areas, and also results in continual disputes between the contractor and the engineer. It is believed that a fairer basis of payment is the weight of materials actually used. This can be determined, as intimated in the foregoing, from the records of the plant inspector, who should be required to keep not only batch weights, but a record of load weights sent out from the plant. (If it is desired to estimate the yardage of work done, it is possible to determine the average weight per cu. ft. and per sq. yd. of any depth of asphaltic materials.)

System of Checking Loads

A system of checking up loads which has been tried out with some success is as follows: The plant inspector has a pad of tickets on which are recorded in duplicate the load weight and the designation of the load, as well as the serial number of the ticket. One copy is given to the driver of the wagon or truck, and the second is retained by the inspector at the plant to be sent in to headquarters with his reports. The driver presents his ticket to the inspector on the street where he delivers the materials and this inspector countersigns it as received. The driver's ticket then is collected by the superintendent of the contractor and is used as a claim for payment for the weight of materials delivered. These tickets, of course, are checked up by the municipality with the copy retained by the plant inspector.

Payment According to Weight

The payment for work done according to weight of materials used does away with any argument with the contractor as to the fairness of measurements taken on the street and tends to eliminate the possibility of collusion between inspectors and contractors in the taking of measurements. Where it has been tried out it has met with the approval alike of the municipal officers and the contractors.

Importance of a Work Program

In street maintenance work, as in any work of magnitude, a well devised work program is essential for best results. It should be made legally possible for the officer responsible for street maintenance to order streets resurfaced when the period of economic repairing ends. This end point would have to be determined from carefully kept records of the annual cost of repairs and would be reached when this annual cost of repairs capitalized equaled the cost of resurfacing. Such determination, of course, would have value only if all work necessary to maintain the pavements in first class condition were done each year.

Street Maintenance

Street Pavement

From To

Ord. C. C. Page 19 Completed Guar. Exp

Length Width Area Car Tracks

Total cost Imp. Cost per yd. Pav't Cost per yd. Surface

Year	Yds Repaired	Labor	Material	Total	Overhead	Total	Cost per Yd. Repaired	Cost per Yd Area

FORM OF FILE CARD FOR KEEPING RECORD OF ANNUAL MAINTENANCE EXPENSE OF IMPROVED STREETS.

This Record is a Valuable Aid in Determining when Resurfacing Becomes Economical.

The engineer in charge of street maintenance should make a careful inspection of all pavements in his care at least twice each year. At the end of the repair season inspection should disclose the approximate amount of work to be done next season, as well as the general condition of the pavements. The latter information is necessary both as a check on the work done, and to plan the rate at which the work must progress during the next season in order that it may be completed. An early spring inspection is necessary in order so to route the work as to repair first those pavements in greatest need of it. This inspection also would give information necessary to complete the season's work program and to determine finally from actual physical conditions the quantity of work to be done and the streets to be resurfaced instead of repaired.

A work program for street repairs means more than this, however. There should be prepared in advance of the season a complete schedule of streets to be repaired and the order in which the work should be done. It should also be possible to route the work and estimate the rate of progress so that all of it will be done within the season and so that the approximate time at which work will be done on any street may be known. Such schedules, as well as quantity estimates of materials required, are necessary whether the work is done by contract or day labor. In the first case they form a basis for cost estimates in awarding the contract as well as affording means for

DEPARTMENT OF PUBLIC WORKS, ROCHESTER, N. Y.

PLANT OF_____ INSPECTOR _____ DATE _____

PAVEMENT MIXTURE

BATCH	LBS. A.C.	LBS. SAND	FILLER	STONE	TOTAL	TEMP.	

HEADINGS IN PLANT RECORD OF BATCHES OF ASPHALT PAVEMENT MIXTURE TURNED OUT DAILY, ROCHESTER, NEW YORK.

This Record is Used in Checking up Load Tickets Before Making Payments to Contractors.

checking up progress from time to time and eliminating unnecessary shifting of working forces. When the work is done by the city with its own plant and forces, such schedules are even more important because, in addition to the factors mentioned for contract work, it then is necessary to arrange for the delivery of materials as required.

Senator Chamberlain Encourages Workers for Real Highway Transportation to Continue Their Efforts

In addressing the regional chairmen of the Highways Transport Committee of the Council of National Defense at Washington on Sept. 18, 1918, United States Senator George F. Chamberlain spoke in part as follows:

"I congratulate you on the effort you are making to give the subject a national aspect. It is one that every community however small is interested in. It appeals to every state, to every county and to every lesser sub-division, but it is difficult for individual communities and even for the states, acting individually, to accomplish much along the lines you are now working upon without national aid and co-operation. I think I can safely say that the strict doctrine of state rights is not contended for as it used to be, and federal co-operation and aid are appealed for purposes undreamed of in the days gone by, and in my opinion it is safe to appeal to the federal government and to ask its aid and co-operation in the great enterprise you are entering upon.

"I have always been interested in the subject of transportation from every angle and I have attended with interest and pleasure and have addressed many of the congresses which have met here and elsewhere to further river and harbor improvements, which, like the public highways, are to be utilized for relieving rail congestion. There are many rivers, many streams and many facilities that might be utilized to relieve this congestion and to which the attention of the people is now being directed more generally than ever before.

Everybody Interested in Highway Transportation

"The subject of the utilization of the highways of the country is, or ought to be, near to the heart of everybody and there is no reason why you should not find active co-operation everywhere in your effort to develop this system of transportation of state and interstate purposes. That the railroads are congested goes without saying, due to the fact of the lack of terminal facilities, as well as to the fact that the business of the country has been very largely increased in the past four years since the beginning of the war and it is likely to further increase in the days that are to come.

"There is an additional factor that enters into railroad congestion and that is due largely to the fact that careless business methods have been applied. To illustrate what I mean we will take the railroad systems between the Atlantic and Pacific. They are few in comparison with the need of the country and we find these roads carrying lumber from the far west along navigable streams to eastern shipyards for the building of ships. Why not build the ships where the lumber is cut and put them afloat there, thus relieving the rail transportation to a very large extent. Other illustrations might be given to prove that we are engaged in carrying coals to Newcastle, taking the raw material from its natural habitat to be developed at some distant point where the work cannot be so well done or at least cannot be done so cheaply as where the raw material is found.

"Now these are indications of bad management somewhere and it is hoped that they may be corrected as soon as it is possible to do so. May I be permitted to say that in my opinion *you gentlemen are proposing a plan which will greatly relieve the situation. That plan is sure to be adopted, the country will demand it as soon as they fully understand your purposes and the course you are outlining will add immensely to the wealth of every community.* It adds to the value of the land as well as to the product, bringing the producer and the consumer into immediate touch and contact and will enable the farmer to market his products at his own door at greatly enhanced prices.

"We are just beginning to realize the uses to which the highways of the country may be utilized to aid in the great work of motor transportation. The war has compelled a resort to it, and I believe that congress may be induced to aid the movement by large appropriations to be spent in co-operation with the states and by placing these highways used for interstate purposes under the control of a federal agency with power to prescribe rates and unify the licensing system so that no handicap will be placed upon the utilization of those highways by conflicting laws of the several states.

"You have but to present the matter as forcefully as I am sure you can to your representatives in congress and I predict that good results will flow from your efforts."

Mayor Davis, of Cleveland, Drafts $20,000,000 Public Works Construction Program in Preparing for Peace

The most elaborate public improvement construction program in the history of Cleveland, Ohio, to begin as soon as the war is over, was recently proposed by Mayor Davis of that city as a sure and legitimate means of guaranteeing immediate employment to all returning Cleveland soldiers and sailors, as well as those industrial workers temporarily engaged in the production of munitions of war, irrespective of industrial conditions which may prevail during the readjustment period following the restoration of peace.

In announcing this purpose recently the mayor stated he had already outlined a general plan for a wide post-war scheme of construction of public improvements, which, if approved by the city, would practically solve for the community the problem of the soldiers' return to civilian occupations.

Incidentally, he pointed out, it would be a means of getting for Cleveland urgently needed public improvements which would be of inestimable value to the population as a whole, and to the city's industries.

Not only by the actual work of construction, but also from the benefits issuing from the completed projects themselves, the city prosperity would be given an enormous impetus, he rightly believes.

Projected Improvements Would Cost $20,000,000

To get the improvements advocated by Mayor Davis well under way, would mean an expenditure of approximately $20,000,000. He stated his intention of submitting the entire scheme in the form of bond issues to the voters for their approval as soon as the plan can be shaped into definite form.

The estimate of $20,000,000, he said, would not include the contemplated construction of a subway or other rapid transit system, the financing of which under state law would be taken care of by levy of a special tax, instead of a bond issue.

Preliminary estimates of this undertaking, which is also to be carried out immediately after the war, have placed its approximate cost at about $10,000,000.

Many Projects Involved

"Our first step will be to get all details of the proposed scheme completely worked out and to have its features, so far as they come within that body's jurisdiction, approved by the city planning commission," explained the mayor. "Legisislation will then be offered in city council, to authorize its submission to the voters.

"As the plan involves scores of projects entering into the activities of all departments of the city government, we shall urge that the presentation of them to the people at the polls shall be made in such a way that they may reject any part of them, and still approve the general scheme.

"The many kinds of improvements proposed would require practically all the services for which the returning soldiers are specially fitted."

$13,000,000 Water and Light Improvements

Over one-half of the estimated cost would go in the department of public utilities where the proposed improvements result in a vast increase in the revenue from water rents and electric light and power charges.

In the water department plan alone, it is proposed to construct a water reservoir in Brooklyn, an East Side filtration plant, a new East Side pumping station, and install new mains, at a cost of about $10,000,000.

For the division of light and heat, the plan calls for $3,000,000 worth of extension work, which, according to estimate, would increase the department's annual revenue nearly $1,500,000.

This would cover extension of the 3-ct. light zone to new territories, including the West Side generally and that part of the East Side south of Euclid avenue, between East 40th and East 105th streets.

Principal improvements contemplated in the department of parks and public property include a new bath house at Gordon park, which is to cost about $300,000; construction of a recreation pier at the same place, and erection of a farmers' wholesale market and warehouse, with railroad terminal facilities, to be used by farmers, commission merchants, market gardeners and other distributors of farm produce. The approximate cost of this would be $750,000.

Construction of a new market, to take the place of the present Central market, is proposed, as well as a vegetable and fruit market opposite the West Side market house. Several public bath houses in various parts of the city and swimming pools at Woodland Hills and Brookside parks are also recommended.

Other projects include improvement of Doan brook, which runs through Wade, Rockefeller and Gordon parks; boat houses, a new dance hall at Edgewater park, a golf club house at Highland park, and the establishment of a city park at old White City, on Lake Shore boulevard.

Hundreds of Miles of Paving and Sewers

Under the public service department, hundreds of miles of paving and sewering are to be done, but it is pointed out that bond issues to cover practically all of this work have already been approved by the voters. This work, it is declared, will go forward at the end of the war at all events.

Construction of new traffic lanes on the East and West Sides, to relieve congestion on the present thoroughfares, is particularly urged. Among such projects are extension of Hough Avenue northeast, as far as East Ninth Street; further extension of Carnegie Avenue, southeast, now being carried to East One Hundredth Street, to connect it with East One Hundred and Seventh Street and the boulevard system, and continuation of the same thoroughfare west of East Twenty-second Street, to connect with East Ninth Street; also the widening of East Seventy-ninth and East Thirtieth Streets.

Because of rapid expansion of the city, establishment of garbage collection substations in various sections are declared necessary.

Another improvement which administration officials hope the United States government may permit to be started soon after the end of the war is the straightening of the Cuyahoga river, which in itself will furnish employment to thousands of men.

The Housing Projects

In the public welfare department, the plans are for doubling the capacity of City Hospital and of the tuberculosis sanitorium at Warrensville, and for construction of fireproof buildings for the children's tuberculosis division, and the girls' home at the city farm.

A permanent building program is proposed for the Hudson boys' farm. It is pointed out that the "cottage plan" for wayward boys, now in operation with the idea of creating a home-like atmosphere for the boys, is now considered impractical by the best authorities.

To replace the present eight cottages, housing 150 boys, larger fireproof structures should be erected at rate of one each year, it is recommended.

Remodeling and enlargement of the correction farm buildings is suggested to allow segregation of prisoners.

Civic Centers

Construction of civic centers in Cleveland js another recommendation. In these centers, it is suggested, various city activities, such as police stations, comfort stations, fire engine houses, babies' dispensaries, district physicians' office might be jointly housed.

For the fire and police departments the improvement program provides for construction of three new engine houses in Nottingham, and at East One Hundred and Thirty-first Street, between Miles Avenue and Kinsman Road southeast, and Denison Avenue southwest, and West Sixty-fifth Street, and new police stations in Corlett and at Denison and Lorain Avenues; also for rebuilding and enlarging eight of the present station houses.

All these recommendations are on the basis of reports submitted to Mayor Davis by Public Utilities Director Farrell, Parks and Public Property Director Waite, Public Service Director Bernstein, Public Welfare Director Beman and Public Safety Director Sprosty.

Regulations Pertaining to Pipes, Tanks and Accessories Issued by War Industries Board

A meeting of the Building Materials Section of the War Industries Board was held Sept. 27, 1918, Council of National Defense Building, at which there were present representatives of the Army, the Navy, the U. S. Housing Corporation, the Supervising Architect's Office (Treasury Department), the U. S. Railroad Administration, and representatives of the Director of Steel, and the Priorities and Conservation Divisions of the War Industries Board.

Final consideration was given to regulations promulgated on Sept. 18, by which there will be effected a saving of upwards of 40,000 tons of pig iron. After thorough consideration, the following was unanimously adopted:

Whereas, the immediate vital requirements of the war program necessitate the rigid conservation of iron and steel, therefore

Be it Resolved that the following regulations pertaining to pipes, tanks and accessories be unanimously adopted by the Building Materials Section of the War Industries Board for immediate application:

The Regulations

1. Nothing larger than 4-in. diameter nor heavier than standard plain cast iron soil pipe is to be used for vertical stacks above ground; the full size stack to be carried through the roof. Portland cement, concrete or vitrified clay pipe shall be used for horizontal lines under ground.

2. There shall be no back vents used.

3. No house traps or fresh air vents shall be used.

4. Water service pipes shall be of ¾-in. galvanized wrought steel or iron for single houses and of proportionately larger size for larger buildings.

5. No patterns for soil pipe and fittings other than those listed in the schedule of the Conservation Section of the War Industries Board shall be used.

6. The installation of gas piping in houses will not be permitted where electricity is available for lighting purposes. This will not prohibit the installation of gas piping for heating and cooking purposes where the extreme extension of the distribution mains to the houses is less than 1,000 ft.

7. No system of gas mains shall be installed in any project requiring an extension of more than 1,000 ft. from the existing source of supply without the special approval of the War Industries Board.

8. No metal pipe shall be used for water mains without special permission of the War Industries Board. This does not apply to pipe lines carrying pressures of more than 100 lbs.

9. The number of fire hydrants shall be reduced to the absolute minimum necessary for adequate fire protection.

10. All water supply tanks shall be of other material than metal.

11. Culvert pipes shall be of reinforced concrete, burned clay, or other material than metal.

12. Cellar floor drainage shall be restricted to the use of underground drains which may be turned up to the floor level and finished with a screw plug connection.

The above regulations shall not preclude the use of existing manufactured stocks provided the metal cannot be utilized for more essential war purposes.

The foregoing regulations shall, with all other conditions therein stated, apply to all construction, municipal ordinances, codes and regulations to the contrary notwithstanding, and no departure shall be made therefrom except where the size of type of the structure make the same necessary in which case special application shall be made to and the approval of the Building Materials Section of the War Industries Board, first obtained.

Concreting Pavement Base in Buffalo, N. Y.

By Geo. F. Fisk, Assistant Engineer in Charge of Pavement Construction, Department of Public Works, Buffalo, N. Y.

All the concrete for pavement foundations in Buffalo is mixed in mechanical mixers.

First Method of Handling Materials

In one method of handling materials the material is placed at one side of the street at the rate of about 1 cu. yd. of material per 5½ sq. yds. of surface to be concreted. It is then clammed into a storage bin; then from storage bin, by means of slide doors, it runs into measuring bins and thence by another set of slide doors it runs directly over an apron into hopper of mixer.

The whole operation requires 22 men, as follows: 2 fine graders, 4 concrete graders behind mixer, 4 cement men (2 unloading, 1 wheeling, 1 dumping cement into hopper), 4 men on clam, 2 men on apron, 1 man operating slide doors, 1 man on bucket boom, 2 engineers, 1 fireman, 1 foreman. This gang will lay about 1,200 sq. yds. of concrete 6 ins. thick per day, giving each batch (12 cu. ft.) 14 revolutions of drum at 24 r. p. m., at a labor cost of about 12 cts. per sq. yd.

Second Method of Handling Materials

The material is placed along the street at intervals of about 1,000 ft., or when possible every other cross street, where the storage bin, measuring box and mixer are set up. The material is clammed into storage bin, from which it runs into a measuring box holding just one batch (8 or 10 cu. ft.). The box is dumped directly into hopper or mixer, mixed for 14 to 18 revolutions of drum at 24 r. p. m., and then dumped into cars, two batches per car. It is then drawn (2 cars at a time) by horse power (1 horse) over a track laid on sub-grade to the point where it is to be deposited. This outfit requires 15 men and 2 boys as follows: 2 men on fine grade, 4 concrete graders and car dumpers on concrete, 4 cement men, 1 man on mixer acting as engineer and bucket man, 1 man on measuring box, 1 fireman, 1 engineer, 1 foreman, 2 boys driving horses. This gang will lay between 500 and 700 sq. yds. per day, depending on distance concrete has to be handled, at a labor cost of about 13 cts. per sq. yd.

We try to get at least 14 revolutions of the drum, the r. p. m. not exceeding 24. We do not measure the amount of water used, insisting only upon a quaking consistency after the materials are mixed.—*From a paper before the American Society for Municipal Improvements.*

Highway Development as Important as Railroad and Waterway Development

By Hon. William C. Redfield, Secretary of Commerce, Addressing the Regional Chairmen of the Highways Transport Committee, Council of National Defense, Sept. 19, 1918

The largest number of railroad tracks paralleling any navigable stream follows today the line of the Hudson. There are six much of the way—four tracks on one side and two on the other. I am going to make that historical line of water and rail transportation the basis for a little study with you, to see what the normal development of transportation is, and whether, as I believe, the particular form that concerns you is a natural outgrowth of all that has gone before. If it is so it is here to stay. If in the process of transportation evolution we have reached the normal use of the highway, together with the waterway and the railway, then you are doing a constructive work for your country. But if that work is not normal, if you are trying to impose upon the body politic something strange and artificial, then your work will, and ought to, fail.

Must Link Up Railways, Waterways and Highways

The transportation system of the United States is not a unity. It cannot be run on what we may call unitarian lines.

VIEWS ILLUSTRATING THE HANDLING OF CONCRETING MATERIALS FOR PAVEMENT BASE, BUFFALO, N. Y.
Left: Material Placed at Side of Street at Rate of 1 Cu. Yd. per 5½ Sq. Yds. to be Concreted. Right: Material Placed Along Street at About 1,000 Ft. Intervals.

It is a trinity, and has to be run on trinitarian lines. You must link up railways and waterways and highways to get a perfect transportation system for this country. If there were no railroads we would have little transportation. If there were no waterways there would be insufficient transportation. If we had an abundance of railways and waterways and lacked the use of highways, we should have imperfect transportation. We should fail to bring it to every man's door, and it must be brought to every man's door to be perfect.

The early transportation in the Hudson river valley was by sloop. The history of the river is full of the traditions from the old sloop days when it was sometimes five and sometimes nine days from New York to Albany by water. The river was just as navigable then as it is now; the difference lies in the tool that was used. Now in that use of the fit tool for the route lies the whole truth in transportation, and yet so far as I know the full bearing of the application of the tool to the job is almost new to our discussions of the several phases of transportation. In due time comes Robert Fulton and the Clermont begins to flap-flap her weary 36 hours from New York to Albany. A new tool but the same route. In time she passed into a more modern type. The steamboat developed, and came the canal with its mule power. How strange it seems in these days to think of mule power ever having been considered. Yet I have in my possession a letter to the constructing engineer of the Erie railroad urging that it should be operated by horses between New York and Buffalo and giving ten very excellent reasons why horses were far better than steam locomotives could be. It took a lot of argument to keep the horses off the Erie railroad.

Motor Trucks Develop Highway Transportation

Came the steam locomotive. Now the rail was not new any more than the river was new. The railroad or tramway in England is far back, earlier than the railroad in America. There were tracks laid many years before anybody thought of a locomotive engine. The invention lies not in the railway, but in the tool put upon it. Again the principle of the tool to the job. Also a new principle that the way, whether it was waterway or railway or highway must adapt itself also to the most effective kind of tool that could be put upon it. You could apply it but partially to the river. When canals came along later, it became apparent that you must not only have the best tool for your waterway, but must suit the latter also to the tool. We understand this about railways; we have not been so clear about it as to waterways and highways.

It is within two years that the governor of a great state has suggested to me that the use of large motor trucks be forbidden because they destroyed highways. I ask you if you will warrant the removal of locomotive engines because they are made 100 tons heavier and would break the light rail made 40 years ago. The problem is a duplex one. The best tool must be had for the job and the opportunity must be provided for the tool to do its work.

So the railway came along and since the mechanical engine fitted so perfectly into the American temperament and the national need, the railway and the tool for the railway developed together side by side. Still with the coming of the railroad we thought of transportation as a unity. Highways did not amount to very much. Men went by horseback often because they had to, not always because they wanted to. And after the railroad came, the waterway was all but destroyed, because we thought of transportation as a unity of railroads. Up to a very few years ago, all of us who are not far-seeing would have thought of public transportation as meaning essentially the railroads. Yet so rapidly in the last five years has the law of transportation been developed that it is a little bit difficult for us to keep up with the rush of this movement.

Internal Combustion Engines Rejuvenate Waterway and Highway Transportation

There came into the world a new tool: The internal combustion engine, destined to work almost as great a change in the human life as the steam engine in its time, making possible a tool for the waterway that the waterway had never had before, making it possible to use for the highway what the highway had never had before, making necessary the alteration of the highway to suit the new tool built for it. It has never been true until now and it has just now become true that the waterway and highway have been, as regards the tools for their use, on a technical and scientific level with the railway. The Government is just putting in operation this month the first great barges for the Mississippi river, intended to carry ore south and coal north, made possible because of internal combustion engines. The tool has come, the internal combustion engine is altering the face of the marine world, so that we do not really need but 6 ft. of water in the northern Mississippi to carry 1,800 tons of ore in one boat. We look upon the development of the New York state barge canal with a certainty of its profitable use for the nation, for with a 12-ft. draft we know we can carry 2,500 tons in any vessel constructed for the purpose, driven by internal combustion engines. The tool for the job and the way made ready for the tool.

I go into my shop to put up a hammer. What is the essential feature of my hammer's operation? The foundation. It may be the most powerful hammer made, but unless given a sufficient sub-structure, it can only be destructive. So for the waterway, so for the highway. You may have the most perfect equipment for their use, but the instrument must work in a proper environment. So the waterway then, the last few years, in fact very, very recently, has come rapidly into its own. It is within 18 months, gentlemen, that I stood upon the first load of ore going south on the Mississippi river and saw it enter the port of St. Louis. It was only yesterday that I sent to the Senate my formal report, urging Government ownership and operation of all the northern coastal canals from North Carolina to New England, with the certainty that adequate and efficient vessels could be provided for their use.

Three Forms of Transportation Supplament Each Other

Now these three ways of transporting developed to their full, are not hostile to each other. In the days of our ignorance we thought they were. In other times the railroad bought canals to suppress them. But we have learned a larger outlook now and the congestion so recently as a year ago taught us that there are certain kinds of goods, certain types of transportation, that the railways of this country cannot afford to do. Certain great items of bulk freight, they must always carry. We should starve for steel if we had to depend upon our railroads to bring the ores from Minnesota to Pittsburgh, and the Northwest would be in a hard case if we had always to send coal to them by rail from the region of the East. We are learning that there is a differentiation in transportation. So these two enemies of the past are likely to operate as friends today. It is not a chance thing that the internal waterways of the country are at this time being operated by the Railroad Administration. It means an advance in thought.

I told the Director General of Railways that two-thirds of the job was fairly well in hand but that he had left out one-third, and that I thought he would not get his unity complete until he made it a trinity by taking in the highways. I told him that the highways as a transportation system and their development both as to roads and as to means of using the roads were quite as essential to the country as the other two. In reply he suggested that it was a larger job than he himself could undertake, with the railroads and the waterways on his hands, and asked me if I would not

do it. To my regret I was obliged to refuse. The law does not give me authority. I should have been glad if I could have had more of a part in it, because given your perfected railroad, and I speak as a friend of the railroad and as a friend of the waterway which I think is also coming into its own, I am convinced that neither will reach its normal place as a servant of the people unless linked up with motor truck routes.

Motor Trucks Feeding Steamboat and Railway Lines

There is a steamboat line running from New Haven to New York. At New Haven, lines of motor trucks radiate out in several directions. From this radius around New Haven for many miles in three directions the motor trucks come down in the evening to the boat. The boat leaves a little before midnight and arrives in New York in the morning, when the freight is transferred and goes out on the early trains for the West. It is a good system of interlocking service such as we have got to have.

My conception of the future of the New York barge canal and the canal across New Jersey and the Chesapeake and Ohio and all the waterways is that the companies operating on them shall pick up and deliver at every important terminal point by lines which shall radiate out by motor trucks from 50 to 100 miles and they shall take from these places goods thus brought to their station. So that if when, for example, they were delivering goods from Kentucky to Illinois, the goods might start from a farm or from an inland village by motor truck and go to the nearest waterway station, there to be picked up by vessel and be carried down the Kentucky and Ohio to a point sufficiently near in Illinois to where it was to go, there to be picked up by motor trucks which would carry it to its destination. And it should be billed through by one bill of lading. That would definitely establish that the vehicle and highways are not accidental or incidental, but an essential factor. That, it seems to me, is what we are coming to before very long. I imagine we will come to it almost before we think of it.

From that are a number of inferences. The public authorities have got to be sufficiently educated to make a good thing possible. They have got to learn, as many a farmer has to learn, that the most costly thing in the world is a bad road, that as compared with sealskin furs and platinum, mud is far more costly an item, and that there is no such evidence of a muddy state of mind in a community as a muddy state of highways in the community. They go together—mental and physical mud.

Transportation in the Hudson River Region

Now let us see whether our idea is false or true in its application. The Hudson river has by it six tracks of railroad. The fleet of vessels upon the Hudson river was never as great, never so new, or well equipped as today. The vessel with the largest passenger capacity, or at least second largest (6,000 persons), is in operation on that river. The freight carried on the river amounts to over 8 million tons a year by water. I put a factory at Troy because I could get by water, express service at freight rates loading machines on the boat in the evening and have them delivered in New York the next morning, while to ship the same material by railroad to New York would require 3 to 5 days by freight.

Directly back from the river bank on either side are two of our fine highways. Neither the railroad nor the river meet all the needs of the men living on those roads. You might build the railroads up until they are ten tracks wide, but you do not fully help the farmer ten miles away to get his produce to market. And you might fill the river with steamers, and he may be still isolated. There must come something to his farm which transports his produce easily and systematically and in harmony with other methods in duplex action going and coming. So our friend the farmer must have the Rural Express or its equivalent which comes to his door, which in the morning connects him up with all the round earth and brings him what he wants of the earth's products back to his door that night.

The Rural Express

I cannot think of that except as a matter of common sense. It is a thing which has got to be, and in a very few years, at least, will be as accepted as such things as the rising of the sun and the setting of the sun. It will be considered normal. You will even find, if you have not already found, farms offered for sale on the basis of having a Rural Express coming and going on one side of it, perhaps on two sides of it as we get into it more thoroughly. The whole rural postal delivery system was the promise and pledge of the Rural Express. What we do when we send the motor truck through the rural centers is to push the Rural free delivery and the parcels post service just one step forward.

Motor Transportation in the Far North

I have had motor trucks put on the Pribiloff Islands in the Behring Sea. They are building the roads to run on before they can run on them. And there, 250 miles north of the Aleutian Islands, we can make motor trucks pay for themselves in a single year, by the force they add in effective transportation. We have a seal rookery 13 or 14 miles from the village of St. Paul Island. We have not been able to kill seals there because we could not get skins down to the village. Now a couple of motor trucks bring them down without the least difficulty, and in order to get the road there they carried down materials to build the road. So in the same way we have a great many fishery stations isolated. You cannot put fish hatcheries in towns. We get them as far off as practicable. The problem is to get sufficient water and isolation, and so those stations are rather difficult to reach. In those places today we have put motor trucks. Here, with these important stations, 6 8, 9 and 10 miles and sometimes more away, it was perfectly obvious that the best, simplest and quickest means of access was necessary, and for several years now we have been putting little trucks in there. They have changed the effectiveness of the whole thing.

Conclusion

That is all very simple. I imagine that one great difficulty in this world is that the simple things are sometimes very hard to bring about. It is true in a certain sense that if we bring to a man something that is difficult and complex, it catches the mind, by its very complexity and strangeness. But if we come to him and say that mud is one of his worst enemies, it seems hard to him that it could be as bad as it really is, as he is sort of friendly toward the mud. So many are familiar with the automobile, not as familiar, I believe, as they are going to be, that it seems hard to think it can work as revolutionary a change in their life as it is going to do. But I am perfectly certain that there abide these three elements of transportation, railway, waterway, and highway, that they are one, and that none of them will reach its full value to the community without the other and that each is the friend of the other.

The Blast Furnace Slag Section of the Youngstown-Akron (Ohio) Concrete Highway

The Youngstown-Akron road is an extension of Mahoning Avenue, Youngstown, and is the main artery of travel between Youngstown and Akron, Ohio. A section of this road was built of blast furnace slag concrete and has been in use long enough to demonstrate the value of blast furnace slag for road building uses.

The section is a mile long, just out of Youngstown. Here the road is 20 ft. wide with 6 in. edge and 7 in. center. It was built in 1913 during the months of October and November, and thus in part during freezing weather, under the super-

vision of the State Highway Department of Ohio together with joint inspection by a representative of the Portland Cement Association.

The foundation of the road is dirt, graded and rolled. The road itself is monolithic concrete, made of ¼ in. to 1 in. blast furnace slag aggregate in a 1:1-½:3 mix. Cement was Newcastle cement made by the Newcastle Cement Company (which is now owned and operated by the Lehigh Portland Cement Company), the sand was Ohio river sand, and the aggregate was crushed and screened blast furnace slag from the Ohio Steel Works and Furnaces of the Carnegie Steel Company at Youngstown. The wearing surface was obtained by richness of mix. Carey expansion joints ¾ in. wide, were located every 30 feet.

During the construction of the road in places where the soil contained considerable water from local springs, lateral cracks appeared after the concrete had set and these were corrected by the application of tar. These cracks continued to develop during the period of about six months after the

VIEWS ON BLAST FURNACE SLAG SECTION OF YOUNGSTOWN-AKRON (OHIO) CONCRETE ROAD.

road was built and there has been no extension of them since.

Until last year the character of the travel was largely pleasure vehicles, averaging about 50 an hour. During the last year there has been an enormous amount of trucking done over it, due to the establishment of a truck freight route through Youngstown, Akron, Cleveland, etc. At a recent tally while an observer was taking photographs 27 vehicles passed, eight of which were heavier than 2-ton trucks. Seven and 8-ton trucks also travel on the road and the character of the service, therefore, has thoroughly tested its endurance.

The road at present is in an excellent state of preservation. The only maintenance it has had in five years has been the filling of local cracks with coal tar. Representatives of the committees of several technical societies as well as engineers who have inspected the road agree that it is among the best examples of concrete highway construction in the country in existence and, further, that after five years' service the amount of wear on the road is negligible.

Grade Crossing Signs Required on Illinois Highways

The Public Utilities Commission of Illinois has ordered the protection of highway traffic at dangerous railroad crossings. Special road signs are to be employed for this purpose. The warning signs must be placed 300 ft. from the crossings by the local highway commissioners. Of course, these signs are placed in addition to those placed on the right-of-way by the railroad.

The railways have no authority to place these approach signs outside their property, so the duty falls on the public official. The railroad sign is inadequate because of the speed of motor traffic, especially where the view of the crossing is obstructed by trees, embankments or curves. "Extra hazardous" crossings are protected by two approach signs.

Miles Acid Process for Recovery of Sewage Grease with Special Reference to Sewage of New Haven, Conn.

By C. E. A. Winslow, Professor of Public Health, Yale University, and F. W. Mohlman, Chemist, Connecticut State Department of Health, New Haven, Conn.

Ordinarily city sewage contains two types of valuable substance, fertilizing materials and grease. Clark has estimated that the nitrogen in sewage would theoretically be worth $52 per million gallons, the fats, $7, the potash, $5, and the phosphorus, $4; but a large proportion of the materials are not present in an available form. Much of the phosphoric acid for instance is insoluble. The water and grease content of the sludge is the great obstacle to its use. The Metropolitan Sewage Commission of New York (1914) concluded that a sludge containing 50 per cent of moisture on the wet basis and less than 10 per cent. of grease and at least 3 per cent. of ammonia on the dry basis might be further dried and ground at a profit on a large scale, but that "no other than an occasional and uncertain offset to a part of the cost of operation can be looked for, even under favorable circumstances, from the sale of sludge in the form of crude cake or containing over 30 or 35 per cent. of moisture."

The Miles Acid Process

Interest in the possibility of recovering grease from sewage has recently been stimulated in this country by the claims made for a process of acid treatment patented by George W. Miles of Boston, and first reported upon by Prof. R. S. Weston of the Massachusettts Institute of Technology in 1916. The treatment consists in "the addition of an acid, to precipitate the bulk of the solids from sewage in the form of a sludge which can be dried and degreased, thereby producing a readily salable and greaseless fertilizer, as well as recovering the valuable grease. Either sulphuric or sulphurous acid may be used and the process contemplates the manufacture of the acid at the disposal works. If sulphuric acid were chosen, ordinary weak chamber acid of 1.53 specific gravity would be used, but the cheapest source of acid is undoubtedly pyrite (native FeS_2), which, when roasted in a furnace of proper construction, produces sulphur dioxid (SO_2). This is a gas which may be fed directly into the sewage, in which it would dissolve, forming sulphurous acid" (Weston, 1916). The sulphur dioxid is a strong disinfectant and accomplishes a material disinfection of the sewage as well as considerable clarification.

Scope of Experiments at New Haven, Conn.

The most extensive investigations of this process, so far conducted, have been carried out by the writers at New Haven, Conn., during the years 1917 and 1918. Conditions here seemed *a priori* unusually favorable to the process of acid treatment. It was desirable that the effluent to be produced should be clarified and disinfected, but not necessarily nitrified, precisely the results which the Miles process aims to produce; and the sewage was known to be of low alkalinity on account of the presence of acid industrial wastes.

The total cost of the investigation was somewhat under $18,000. The experiments covered fine screening, Imhoff tank treatment and activated sludge treatment and chlorination as well as acid precipitation, but it is only with the latter that we are here concerned.

Our studies on the Miles acid process were made at two of the five different outfall sewers of the City of New Haven. Four different runs were made with the East Street sewage and one run with the Boulevard sewage, each run ranging from 24 to 75 days. The tank used at the East Street outlet was of wood, 16 ft long, 3 ft. 6 ins. wide, and 4 ft. deep, with a capacity of 1,680 gals. and the average detention period was 4 hours. The tank used at the Boulevard sewer was a smaller wooden tank, 8 ft. 10 ins. long, 5 ft. wide and 2 ft. 8 ins. deep with an effective capacity of 860 gals., the average detention period being again 4 hours. The acid was applied in the form of SO2 gas delivered through a rubber tube into the sewage as it flowed to the tank through a 2-in. galvanized pipe 18 ft. long. The amount of gas was controlled by noting each half hour the loss of weight of the SO2 cylinder which rested on a platform scale. The alkalinity of the East Street sewage is very low (averaging only 50 parts for the four runs), so that it was necessary to add only 700 lbs. of acid per million gallons of sewage treated to secure an acidity of 50 parts per million (as calcium carbonate).

At the Boulevard sewer 1,130 lbs. of acid per million gals. of sewage were required to secure an acidity of 50 parts per million (as calcium carbonate).

General Results of Miles Acid Treatment of New Haven Sewage

The general results of the acid treatment were highly satisfactory. The effluent was well clarified and showed a good bacterial reduction. The removal of total suspended solids amounted to 61 and 66 per cent. respectively at the two outfalls, and the removal of settleable solids to 90 per cent.

Bacterial Reduction

The sewage of the East Street sewer is an abnormal one, showing a very low bacterial count as a result of the presence of copper salts contributed by industrial wastes. The results obtained with about 800 lbs. of sulphur dioxide at East Street and 1,483 lbs. at the Boulevard, are less striking, but on the whole very satisfactory. During the first run at East Street we added an insufficient amount of acid and the treated effluent had an average acidity of only 12 parts per million. Yet even in this case the removal of total bacteria averaged 85 per cent. and of B. coli types 98 per cent. The removal of total bacteria averaged 85 per cent. in the second run, 98 per cent. in the third, and over 99 per cent. in the fourth run and in the Boulevard test. The removal of gas forming organisms was 89 per cent. in the third run and over 98 per cent. in all other cases. Of all samples of effluent examined at East Street 91 per cent. showed less than 10,000 bacteria, 84 per cent. less than 1,000 B. coli per c. c., while at the Boulevard 91 per cent. showed less than 10,000 bacteria and 41 per cent. less than 1,000 B. coli per c. c.

It is particularly important, from the standpoint of the practical sewage works operator, to note that both effluent and sludge were so affected by the acid present as to be stable for considerable periods, so that with a plant of this type no local nuisance need be anticipated. During the whole period of our experiments there were only one or two occasions on which slight signs of septic action were noticed in the tank and the sludge was stored in barrels for weeks without the production of offensive odors.

Comparison with Plain Sedimentation

We thought it worth while to examine the comparative results of plain sedimentation and the Miles acid process. From Aug. 17 to Sept. 27, 1917, we operated the Miles acid tank as a plain sedimentation tank, using the same quantity of sewage and the same procedure in all respects, except that the addition of acid was omittted.

According to the results but 40 per cent. of the suspended solids were removed from the sewage by plain sedimentation, as compared with 60 per cent. by the Miles acid process. Septic conditions were pronounced in the tank, as the increase in ammonia nitrogen and alkalinity indicate. Bacterial determinations were not made during this test, but there is no reason to suppose that the count decreased to an appreciable extent, particularly in view of the offensive condition of the sludge.

The sludge was higher in moisture content than was the Miles sludge, and there was much less sludge and grease recovered. This was partly due to the low suspended solids in the raw sewage, but even if there had been 105 parts, as in the acid tests, instead of 88, the sludge and grease recovered would have been respectively 360 and 70 lbs. These quantities are 75 per cent. and 58 per cent. of the quantities recovered by the acid process.

Average Results by Various Processes

Table 1. shows in summary form the average results obtained from the treatment of the East Street sewage by the various processes studied. It will be noted that with the particular sewage in question, which is so difficult to treat by biological methods, the Miles process gave us a better purification as measured by removal of total suspended solids, volatile suspended solids and settleable solids than any other method of treatment. Only from the standpoint of turbidity and ammonia, N, did even the activated sludge process, as applied by us, yield a superior effluent; and the superiority in this case was but slight.

TABLE I—COMPARATIVE RESULTS OF VARIOUS PROCESSES STUDIED—PER CENT. PURIFICATION.

			Solids		
	Ammonia N.	Turbidity	Total suspended	Volatile suspended	Settleable
Wire mesh screens	...	...	15	...	41
Plain sedimentation	—30	23	41	34	86
Imhoff tank	—12	14	43	38	69
Activated sludge	13	44	55	50	74
Miles acid process	0	36	61	54	90

Amount and Character of Grease Recovered from New Haven Sewage by the Miles Acid Process.

The information obtained in our New Haven experiments in regard to the amount and general character of the Miles acid sludge are presented in Table II.

TABLE II—CHARACTER OF MILES ACID SLUDGE AT NEW HAVEN

	East St. Sewer				Boulevard Sewer
Length of run	25 days	24 days	44 days	70 days	29 days
Total gals. sewage treated	260,000	239,400	407,820	602,220	142,500
Gals. wet sludge per m. g. sewage	3,750	4,025	3,200	2,600	5,375
Specific gravity	1,067	1,048	1,054	1,061	....
Per cent. moisture	86.6	88	86.3	85.7	92.5
Pounds dry sludge per m. g. sewage	503	483	439	368	403
Ether extract, per cent. dry sludge	23.7	24.0	29	32.6	30.9
Ether extract, pounds per m. g.	119	116	127	120	124
Volatile matter, per cent. dry sludge	47.2	51.2	57.3	63.8	78.5
Nitrogen, per cent. dry sludge	1.6	1.6	2.4	2.0	3.0

So far the results of the New Haven experiments were very favorable to the Miles process; but when the grease which had been recovered was studied with more care in order to determine its real commercial value, the aspect of the matter began to change. The difficulty lies primarily in the presence of a large proportion of unsaponifiable material (waxes, mineral oils and similar substances) in the ether extract, substances of this kind being practically worthless and their presence necessitating costly processes of purification. The grease recovered from the sludge of the third 44-day run when analyzed by Dr. Raymond Wells yielded 24 per cent. of grease, 46 per cent. of

tankage, and 28 per cent. of water. The grease analyzed as follows:

Moisture and volatile matter	11.0
Unsaponifiable material	21.1
Free fatty acids (by weight)	40.2
Neutral grease	22.3
Insoluble and metallic soap	3.3

Of the 40.2 per cent. of free fatty acids, 14.4 per cent. was rosin and 25.8 per cent. was actual free fatty acids.

The degreased sludge contained 3.91 per cent. of nitrogen as NH3, .96 per cent. of phosphoric acid, and P2O5, and 51.88 per cent. of ash.

The grease obtained from the other three runs made with the East Street sewage contained respectively, 19.8 per cent., 20.7 per cent., and 28.3 per cent. of unsaponifiable material.

The Boulevard Plant

In view of the fact that the East Street sewer receives contributions of mineral oil from a munition factory, it was thought that the large amount of unsaponifiable material might be due to this cause and the Boulevard plant was installed to test this point on a sewer which carries a fairly normal domestic sewage. The result here was distinctly better, the proportion of unsaponifiable material being only 15.7 per cent. with 41.5 per cent. free fatty acids, 0.5 per cent. moisture and volatile matter, and 1.3 per cent. insoluble impurities. Even this value is still so high as seriously to impair the value of the grease.

It seems probable that a fairly high content of unsaponifiable material is a normal characteristic of grease obtained from sewage sludge. Thorpe in his *Dictionary of Chemistry* says "sewage fats are characterized by large proportions of free fatty acids. The amount of unsaponifiable materials also is considerable. The nature of this has not yet been investigated. Probably it consists to a large extent of coprosterol which forms an important constituent of excrementitious matter." Lewkowitsch in *The Technology and Analysis of Oils, Fats and Waxes* notes the presence of 11.6 per cent. of unsaponifiable material in the grease obtained at Cassel. The source of this material is apparently the feces themselves, for a review of the literature shows that of the other extract of dried feces (which amounts to 27-35 per cent.) 12-14 per cent. is unsaponifiable matter, about half of the latter perhaps, being cholesterol.

Value of Products Obtained from the Miles Acid Process

The usual limit for unsaponifiable matter in grease to be used for soap making is about 5 per cent., and unless grease containing 10-20 per cent. of material of this kind could be economically distilled it could be used only as wool grease, which is worth about half as much as garbage grease, or 5 to 6 cts. a pound according to the high prices of 1918. Samples of the sludge obtained from New Haven sewage were submitted to Colgate & Company and the Cobwell Corporation of New York and to Swift & Company and Armour & Company of Chicago, and the chemists of all of these concerns, after extracting the grease and studying it, were of the opinion that in its crude state the material was of practically no value to the soapmaker. If such grease is to be utilized it must be first freed from its impurities by distillation.

Boulevard Sewage

P. F. Wild, vice-president of the Falk Company of Pittsburgh, arranged to distill a 4-lb. sample of the grease obtained from the Boulevard sewage. The material was saponified and then decomposed and the fatty acids obtained were distilled. The product which resulted was light brown in color but had a noticeable odor, although the chemist of the Falk Company reported that it was much less offensive than garbage grease. He added that the grease "can be worked in practical manner if the sulphurous fumes which are in combination with the oil can be removed. Otherwise during distillation this considerable sulphurous acid involved is more or less destructive to the apparatus used, and which imparts a rather disagreeable odor during the distillation."

The distilled grease thus obtained amounted to 70 per cent. of the crude grease, which yielded in addition 3 per cent. of glycerine and 22 per cent. of pitch.

According to the estimate of the William M. Ware & Company, the crude product as obtained from the sewage should be worth 8.5 cts. a pound, and the grease from the East Street sewage (containing 25 instead of 15 per cent. of non-saponifiable matter) not over 6.5 cts. The other extracts obtained from both sewages varied, as determined in the laboratory between 116 and 124 lbs. per million gallons, but the extractions made for us by the Cobwell Company and the Colgate Company indicate that not more than 100 lbs. could be safely assumed on a commercial scale in either case. On this basis the Boulevard grease would be worth perhaps $8.50 per million gallons. The grease free tankage corresponding to 100 lbs. of grease per million gallons would amount to 300 lbs. for the Boulevard sewage. This grease free tankage contained 4.8 per cent. of ammonia worth at $4.00 a unit (20 cts. a pound) $2.88 per million gallons. The Boulevard sewage would therefore yield products worth altogether $11.38 per million gallons.

East Street Sewage

Our data in regard to the grease obtained from the East Street sewage is less satisfactory, since this material was not distilled on a commercial scale. Dr. W. S. Richardson of Swift & Company, and Dr. Paul Rudnick of Armour & Company, believed the crude product to be practically unsalable. Dr. M. H. Ittner of Colgate & Company, found 20 per cent. of unsaponifiable material in his sample and emphasized the fact that the grease would have to be distilled and would probably yield less than 60 per cent. of fatty acids. Mr. G. A. Molleson of Kuh & Valk, grease brokers of New York City, considered the grease as submitted to him to be unsalable and suggested that if the total of moisture, volatile matter and unsaponifiable matter could be brought below 20 per cent. it might be worth 5 to 6 cts. Dr. Raymond Wells of the Cobwell Corporation thought that even for use as wool grease distillation would be necessary and that some of the mineral oils present in this sample might possibly go over in the distillate, making even the distilled product unsuitable for soapmaking. He thought 5 to 6 cts. a pound would be as much as the grease was worth. He noted also that the composition of the sludge was such as to promise certain difficulties in extraction if the process were not carefully controlled. Dr. Rudnick had the same experience, reporting clogging and difficulty in the separation of the finely divided sludge from the gasoline extract. He also noted that the dried tankage obtained was objectionably fluffy.

Altogether, in view of the peculiarly unfavorable characteristics of this particular sludge we do not believe it would be safe to assume a value for the crude product of more than 5 cts. per pound. This estimate, however, we feel is not too high in view of the possibility of distilling the grease and its suitability for wool grease if not for soapmaking. This would amount to a return of $5 per million gallons.

The East Street sewage should yield 350 lbs. of tankage per million gallons, but its tankage contains only 3 per cent. of ammonia, giving a tankage value of $2.09 per million gallons, which with a grease value of $5 would give a total return of $7.09.

Cost Comparisons with Other Methods of Treatment

For the treatment of East Street sewage the possible alternative process for the Miles acid process are: Imhoff treatment and fine screening in each case to be followed by disinfection. The estimated costs of treating East Street sewage per million gallons are as follows: Miles acid process, $8.41; Imhoff tanks and chlorination, $11.99, and fine screen

and chlorination, $11.03. The comparative estimated costs for treating Boulevard sewage are: Miles acid process, $9.60; Imhoff tanks and chlorination, $12.14; fine screening and chlorination, $12.35.

General Conclusions as to the Applicability of the Miles Acid Process

We have discussed the possibilities of acid treatment in connection with the two main outfall sewers of New Haven to emphasize the old truth that there is no panacea for the ills with which the sewage expert deals, but that each individual problem must be dealt with on its own peculiar merits.

The following conditions make the Miles acid process peculiarly adapted to the solution of local difficulties in the case of the East Street sewage.

(a) The necessity of locating the plant in a thickly settled district where treatment on filter beds would be impossible and sludge disposal difficult and the production of offensive odors fatal to success.

(b) The character of the soil at the outfall which would make the construction of deep tanks costly.

(c) The presence in the sewage of antiseptic industrial wastes which would make the results of Imhoff treatment or any other biological process uncertain.

(d) The necessity for removing an appreciable proportion of finer suspended solids in order to avoid deposition in harbor channels.

(e) The probable necessity for bacterial purification in order to protect shellfish layings and bathing beaches.

Against the acid process on the other hand is the small amount of sludge deposited by the sewage and above all, its high content of mineral oil and other unsaponifiable matter. Yet the balance is on the whole clearly in favor of acid treatment.

At the Boulevard outlet conditions (a), (d) and (e) again operate in favor of the acid process and the grease to be obtained is of much better quality. On the other hand the high alkalinity of the sewage makes acid treatment costly, while Imhoff tanks could be built without difficulty and would not be hampered in their operation by industrial wastes. Treatment by the Miles process would not on the whole seem to be indicated at this outfall taken by itself, but might be advisable as part of a general plan for the city as a whole.

Our experience with New Haven sewage lends no color to the hope that a net financial profit can be obtained by the use of the Miles acid process unless with sewage of exceptionally high grease content and low alkalinity. They do however, suggest that for communities where clarification and disinfection are desirable—where screening would be insufficient and nitrification unnecessary—the process of acid treatment comes fairly into competition with other forms of tank treatment; and that it is particularly suited for dealing with sewages which contain industrial wastes and for use in localities where local nuisances must be avoided at all costs and where sludge disposal could be provided for only with difficulty.

The foregoing data and discussion are from a paper presented at the recent annual convention of the American Society for Municipal Improvements.

Street and Highway Bridge Policy Promulgated by the United States Highways Council.

In view of the absolute necessity of providing for military and naval purposes such large quantities of steel and iron that the use of these materials even for the indirect war needs of the federal government has been necessarily curtailed, often against the strong protests of government engineers, it is the opinion of the United States Highways Council that the street and highway bridge policy of all sections of the country should be based until further notice upon the following principles:

Basic Principles

(1) Every endeavor should be made to keep existing structures in service by all available means, such as: (a) Effective supervision. (b) Suitable repairs. (c) Control of traffic. (d) Prohibition of use of bridges by street car, road rollers, traction engines, and other heavy vehicles.

(2) The possible relief of a weak bridge by a detour utilizing a safe structure should be investigated. The improvement of such a detour by using materials which can be obtained without serious delay may be preferable as a war-time measure to the reconstruction of a steel bridge.

Not Easy to Substitute Concrete for Steel Bridges

(3) In some sections of the country the urgent government requirements for cement are now very heavy. Public officials should not forget that materials like cement and brick, which require fuel for their production, cannot now be turned out in the same quantities which were made in peace times, for the fuel is needed in war industries and for absolutely civil purposes. Consequently, public officials are not justified in assuming that if they change their plans for proposed structures from steel to concrete, it will be possible for them to build new bridges without any difficulty.

Procedure in Getting Projects Approved

(4) If public officials find that it is impossible to maintain existing structures and cannot substitute temporary bridges for these that are unsafe, they should apply to the United States Highways Council through their State Highway Departments for approval of their projects. An application should be made out for each bridge on forms obtainable from the State Highway Department. With each application there should be a statement of the size and date of construction of the bridge, the conditions of the piers and abutments, any stream conditions such as floods or caving banks which affect the maintenance or reconstruction of the bridge, the local materials available for bridge work, and evidence of the impossibility of maintaining the present structure or substituting a temporary structure of materials obtainable without government assistance. Public officials are reminded that the United States Highways Council looks to them for assistance in reducing to the absolute minimum the bridge materials required.

Three Classes of Worthy Bridge Projects

(5) The council contemplates three classes of bridge projects which appear worthy of favorable consideration during the war period.

1. A bridge urgently required as a military necessity and so recommended by the representative of the War Department to the United States Highways Council.

2. The replacement of an unsafe bridge which can not be made safe through suitable repairs, traffic regulations, or detour.

3. Replacement of a bridge which has been destroyed and which is essential as a direct or indirect war need.

Extent of the Operations of the U. S. Housing Corporation

One of the significant results of the war has been the necessity for the United States Government entering the field of extensive house-building and municipal improvements in centers of extensive war activities.

Need for Housing Facilities

The enormous demand for labor around certain war industrial centers, demands first felt keenly when the allies were buying their supplies in the United States, created an intense need for housing facilities, particularly for the more skilled classes of labor; a need multiplied many fold since the United States has entered the world contest.

The absence of this housing has led to great inefficiency by reason of the inability of industrial workers to endure uncomfortable conditions in active war industrial centers, and their constant changing from place to place in an attempt to find conditions which were bearable.

Bureau of Industrial Housing and Transportation

This led the Government of the United States to establish in the Department of Labor, a Bureau of Industrial Housing and Transportation, with a view of remedying the conditions described. Under the Bureau there has been organized the United States Industrial Housing Corporation, for the purpose of facilitating construction.

The personnel of the Bureau is the Director, Assistant Director, General Manager, Executive Secretary and the heads of the following divisions:

1, Preliminary Investigation; 2, Real Estate; 3, Transportation; 4, Statistical; 5, Homes Registration and Information; 6, Fiscal; 7, Legal; 8, Architectural; 9, Requirements; 10, Town Planning; 11, Engineering; 12, Construction; 13, Operating; 14, Industrial Relations; 15; Purchasing Division. The work of these Divisions, in the main, can be understood from their titles.

Work of Engineering Division

The work of the Engineering Division consists of the design and construction of all the municipal improvements connected with the housing developments in various parts of the country, also technical advice and aid to the Legal Department of the Corporation in entering into the contract relations with public service companies and municipalities, where necessary, for extension of service, reasonable rates, loans, repayments, and proportioning the cost of these improvements through special assessments proceedings where others besides the Government are benefited, or where extension or connection of existing facilities beyond the limits of the development is necessary.

Fifty Projects Under Way

At the present time about fifty projects are under way, involving approximately 25,000 permanent houses, together with temporary housing in the form of barracks, dormitories, and often hotels, cafeterias, and other necessary buildings. The cost of municipal work is generally about one-fifth the actual cost.

There are approximately 60,000 carloads of materials going into the construction of these various developments under the first appropriation.

Appropriation Made

The appropriation, so far made in Congress to the Department of Labor is $100,000,000, of which $10,000,000 is specifically allotted to the District of Columbia. In addition to this $75,000,000 has been appropriated for the Transportation and Housing Department of the Emergency Fleet Corporation.

It is an interesting fact that the normal expenditure in peace times in the United States for workmen's homes is approximately $1,000,000,000 a year, and the last year it is believed that hardly more than one-tenth of this amount of expenditure has been made.

When it is realized that in Great Britain up to date, there has been expended something like $850,000,000 for housing since the beginning of the war, it will be appreciated that $100,000,000 expended by the Bureau of Industrial Housing and Transportation and $75,000,000, by the Bureau of Housing of the Shipping Board is but a drop in the bucket. It is obvious that if the war continues, greater and greater activity must be shown along the line of housing needs, if industrial workers in active war industries are to be kept at their highest state of efficiency, and shipments of the munitions in ever-increasing quantities are to be sent to France.

An Appreciation of Mud

Capt. R. Hugh Knyvett, the heroic Anzac scout who wrote "In No Man's Land," expressed his opinion of mud in a manner worthy of reproduction in good roads literature: "The Germans had one ally on the Somme that wrought us more havoc than all his armament. How we cursed that mud! We cursed it sleeping, we cursed it waking, we cursed it riding, we cursed it walking. We ate it and cursed; we drank it and cursed; we swallowed it and spat it; we snuffed it and wept it; it filled our nails and our ears; it caked and lined our clothing; we wallowed in it, we waded through it, we swam in it, and splashed it about—it stuck our helmets to our hair, it plastered our wounds, and there were men drowned in it. O, mud, thou daughter of the devil, thou offering of evil, back to the infernal regions and invade the lowest circle of your inferno that you may make a fit abiding place for the slacker and the pacifist!"

Performance of a Motor Street Sweeper in Lansing, Michigan

By C. S. Wilcox, Superintendent of Public Works, Lansing, Mich.

The city of Lansing purchased a motor street sweeper on July 29th of this year and placed it in operation 10 days later.

Previous to the purchase of the machine the city was employing from 25 to 30 men in cleaning our 25 miles of paved streets, with an average payroll of $525 per week, including two teams that were used to haul the sweepings to the dump.

We now employ four hand sweepers who work ahead of the machine sweeping the dirt from the gutters and intersections, and one team with an extra man to haul to the dump, and the machine does the rest. The hand sweepers begin work at midnight, and the machine starts one hour later each night, thus giving the sweepers an opportunity to keep out of the way of the machine.

The business district is thus cleaned thoroughly every night while there is no traffic in the street to interfere, and the balance of the streets are cleaned once each week.

While the residential districts are not cleaned as often as

ELGIN MOTOR STREET SWEEPER IN OPERATION ON S. CAPITAL AVE., LANSING, MICH.

under the old system, they are cleaned much more thoroughly, and from a sanitary standpoint there is no comparison, as the dirt is picked up absolutely without dust.

I submit herewith an itemized account of the actual operating expenses of our street cleaning department for one week which is a fair average for the time the machine has been in operation, which shows a net saving of $324.50 per week, not making any allowance for depreciation of equipment.

Operating Expense for One Week

Operator, 6½ days at $5	$32.50
Four sweepers at $17.50 per week	70.00
Forty-five gals. gasoline at 25c	11.25
Two gals. oil at 50c	1.00

One team, 6 days, at $6.50	39.00
One extra man, with team	18.00
One broom	18.75
	$190.50

While this machine, which is of the Elgin type, appears to be good for many seasons, we figure we would be money ahead if we had to buy a new machine each year.

The Water Supply and Sewage Disposal Plants of Penal and Charitable Institutions of Wisconsin

By W. G. Kirchoffer, Consulting Engineer to State Department of Engineering, Madison, Wis.

This paper will be divided into three parts: (1) A brief description of the water supplies and sewage disposal plants of penal and charitable institutions. (2) What we are doing at the institutions in the way of improving these works. (3) Some suggestions as to care of water supplies and sewage disposal plants, said Mr. Kirchoffer in addressing annual meeting of Power Plant Engineers.

Brief Description of Plants

Starting with the most northerly institution, the Tomahawk Lake Camp for convalescing tuberculosis patients, the water supply is from two shallow, driven wells near the shore of Tomahawk Lake. The sewage is treated in a plain sedimentation tank and then run into a small sand filter intermittently by a syphon. The effluent from the filters runs into a small swamp.

At the Home for Feeble Minded at Chippewa Falls, the water supply is from natural springs flowing into a large storage reservoir. A short time ago, a shortage of water existed here, but by the addition of another spring properly piped and controlled and the raising of the water in Lake Wisota due to the big dam, the flow of the springs has been ample. The sewage disposal of this institution is by broad land irrigation on the sand flats along the Chippewa river.

The Reformatory at Green Bay secures its water from a deep well. Formerly this well flowed at the surface, later was pumped by direct suction, and now is pumped by an air lift pump which needs redesigning. The sewage disposal is by dilution in the Fox river.

The Northern Hospital at Oshkosh has two water supplies. One from Lake Winnebago for general purposes, which is filtered by rapid sand filters. For drinking water the supply is obtained from an artesian well. The sewage disposal plant consists of septic tanks and cinder filter beds; the effluent flows to Lake Winnebago. At the Prison and Central Hospital, Waupun, the supplies are from deep wells. The city takes care of the sewage.

The Industrial School at Waukesha secures its water from a large dug well in a gravel formation, and discharges its sewage into the city sewerage system.

The Tuberculosis Sanitorium at Wales is supplied with water from deep wells pumped by air lift, and has a sewage disposal plant consisting of tank treatment and sand filters discharging into a small creek. This is the only institution that has a separate system for the disposal of laundry water. Here it is treated with lime to neutralize the soap and then passes into a settling tank before going to the filters at the main plant.

At the State School, Sparta, they have three water supplies. The city supply for general use, shallow driven wells for laundry water, and a flowing deep well for drinking fountains.

At Mendota Asylum the water supply is from two deep wells, one pumped by direct suction with steam pump located in a deep pit, and the other by a deep turbine pump of a capacity of 700 gals. per minute. The sewage disposal plant is of the same type as that at the Northern Hospital. The School for the Blind at Janesville has two shallow drilled wells operated by deep well pumps and discharges its sewage into the Rock river without treatment. The School for the Deaf and Dumb at Delavan has a large round well for a water supply, similar to the one at the Industrial School at Waukesha. The sewage flows directly to Turtle creek without treatment.

We have two new institutions in the process of building, one at Union Grove for the feeble minded, and one at Taycheedah as an industrial home for women. At Union Grove the water supply will be from a deep well just completed, and the sewage will be first treated in tanks and then in sprinkling filters. At this institution we have to build a longer outlet sewer than there is now at any institution. It will be two miles long when completed.

At the new Industrial Home for Women at Taycheedah, the water supply will be from springs. These flow by gravity into a reservoir located 100 ft. above the site of the building now under construction, so that no pumping station will be required at present. The sewage disposal plant has not as yet been started, but it will consist of tanks and sprinkling filters with effluent discharging into a drain that leads to Lake Winnebago.

Improvements to Plants

The work that the engineering department is now undertaking at the various penal and charitable instutions outside of the two new institutions is mostly on the water supplies.

At Mendota we are to abandon the present deep well turbine pump for an air lift, pumping into a new storage reservoir. Two steam pumps will raise the water to the elevated tank.

At the prison we are removing an air lift pump and in its place are installing a new air lift of greater capacity and it has the promise of high efficiency. After this work is completed we will likely equip the other well in the same manner.

At the Central State Hospital we have just lowered the cylinder to the deep well by 61 ft. so as to secure sufficient water to supply the pump.

At the State School, Sparta, all of the three supplies contain large quantities of iron that make the waters objectionable for laundry use. Last fall the writer ran a series of experiments on the deep well water to determine the best method of removing the iron for laundry use. It was found that aeration followed by a coke contact filter and subsequent sand filtration would remove all of the iron. Such a plant has recently been designed and will be built soon.

At the Southern Home for Feeble Minded we will install an air lift pump designed like the new one at the prison, Waupun, and a 30,000-gal. storage reservoir will soon be built. The water from the reservoir will be pumped to an elevated tank in the top of one of the silos by steam pumps. No work on the water supply or sewage disposal at the new institution at Taycheedah is in progress at this time.

At the Tomahawk Lake Camp some new sewers will have to be constructed to accommodate the new buildings, and as soon as possible the sewage disposal plant should be moved farther away from the buildings and lake shore.

Care of Plants

Just a few words about the care and use of water supplies and sewage disposal plants. I have been thinking how I could best express the degree of cleanliness that should be observed. Perhaps the following homely statements might express it.

Don't put anything into a reservoir or other receptacles for drinking water, such as a ladder, two-by-four, pipe, chain or rope that is not clean enough to touch your tongue to. Do not allow oil, dust or dirt from the floor to get into the deep wells that you would not spread over your food. It is the invisible dirt, the disease bacteria, that we must keep out of our water supplies. Another thing that is important is the

quantity of water available and the amount consumed. It is very important that complete records, carefully kept, should be made at each institution. Especially is this true of ground water supplies that are more readily affected by dry weather. The consumption should be recorded each day by the number of hours pumped or by a revolution counter and the amounts pumped estimated in this way.

The level of the water in the large wells or springs could be recorded by a float gauge. Then you can see if your supply is gradually decreasing or if it is holding its own. Deep wells could be watched by the use of a deep well air gauge, noting the drop in water when pumping these.

Only a few of the institutions have sewage disposal plants to care for, and the engineers of all of these do not have to care for these plants. The best rule for the care of these plants is: Don't disturb the flow through the tanks more than is absolutely necessary. Keep the filters as clean as possible and alternate the flow so as to allow the air to get into the filtering material.

Sewage disposal plants even when properly designed and operated often give unsatisfactory results, so that it is essential to watch them carefully. A white effluent from the tank indicates fresh sewage, with laundry water in excess of creamery waste, while a black tank effluent indicates a stale sewage or a tank loaded full of sludge that should be cleaned out. We need better methods of sewage disposal and we need more careful attention of these, not only institutional, but municipal as well.

Power Water Main Tapping Machine Successfully Employed in Chicago

It has been the practice of the City of Chicago for a number of years to make tapping connections to water mains under pressure by using a hand-operated tapping machine. It ordinarily required about four men besides the machinist in charge of the work to make taps with this machine, which was operated by means of a lever and rachet.

A new method has been developed for handling this work in order to save time and expense. A 1½-ton G. M. C. motor truck was equipped with a special shaft in the transmission case; this shaft being long enough to extend through the back

COMPRESSOR PLANT OF POWER TAPPING MACHINE MOUNTED ON 1½-TON G. M. C MOTOR TRUCK. THE INSERT SHOWS THE TAPPING MACHINE IN THE TRENCH.

of the transmission case and replacing the idler shaft. This extended shaft provides room for a double jaw clutch and sprocket, which are mounted just back of the transmission. An air compressor is installed on the floor of the truck just back of the cab and is driven by means of a silent chain from the sprocket on the transmission shaft.

The compressor has a capacity of 40 cu. ft. per minute at a pressure of 80 lbs. per square inch. The compressed air is then carried through a hose to an air motor down in the trench, which is mounted on the pinion shaft on the cutting machine and drives the cutters through a train of gears so arranged as to operate the cutters at a satisfactory cutting speed.

This outfit makes cuts from 3 to 8 ins. in diameter inclusive, on all sizes of mains up to 48 ins. in diameter. It is operated by a machinist who, with the truck driver, handles all the work of making cuts instead of a gang of four to six men, as required for the hand-operated machine.

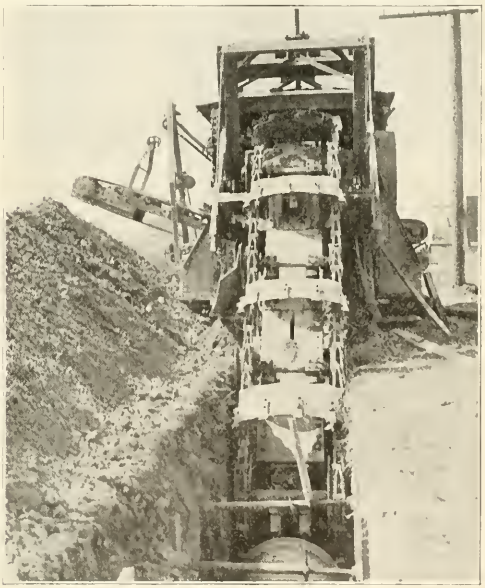
The entire work of making connections to a main is reduced to about 45 minutes, including the time of setting the connection on the pipe, the cutting time, and time of reloading the equipment on the truck. The actual cutting time averages about 15 to 20 minutes. By the hand method of making cuts, the complete operation took from two to four hours.

This equipment has been in service for several months and has proven entirely satisfactory.

Machinery Plays Large Part in Chicago Water Pipe Extension Work

By R. S. Spalding, Engineer of Water Pipe Extension Division, Board of Public Works, City of Chicago.

Trenching machines, and other equipment, have been largely used in laying water mains in Chicago in recent years. A construction force known as "Gang A" was organized in the Water Pipe Extension Division, which handled all pipe laying jobs where trenching machines could be used to advantage. These machines, together with other equipment, with



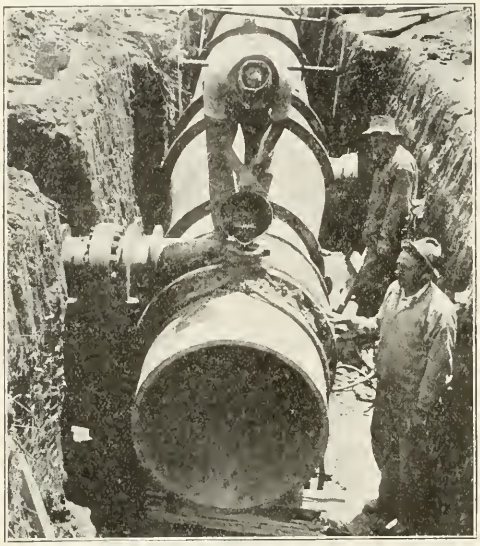
TRENCHING FOR LARGE PIPE. THIS HEAVY AUSTIN TRENCHING MACHINE DIGS ALL TRENCHES FOR 36 AND 48-IN. PIPE.

which this force was supplied, have aided greatly in solving problems due to scarcity of labor.

Excavating Methods

For large mains—36 and 48-in. pipe—the gang is equipped with a No. 0-60 Austin trenching machine capable of digging a trench 60 ins. wide and to a maximum of 10 ft. deep, and a locomotive crane for handling pipe and large castings into place. Thus equipped, 32 men laid a 48-in. main this year at

the rate of 300 ft. per day of eight hours. This job called for a trench 5 ft. wide and 7 ft. deep. The soil through which this trench was dug was hard clay although obstructions, such as boulders and old sheet piling were encountered. However, the trenching machine always traveled faster than the men could lay the pipe and with a slightly larger gang (impossible to obtain at the time) the daily average of pipe laid could have been improved. Trenches for 6, 8, 12 and 24-in. pipe are dug with No. 00 Austin trenching machines. One of these machines has dug as high as 1,100 ft. (per day) of trench 26 ins. wide and 6 ft. deep, but the daily average of a gang of 13 men



POURING METALIUM JOINTS. TESTS SINCE THE COMPLETION OF THIS 48-IN. MAIN INDICATE FREEDOM FROM LEAKAGE.

working with one of these small trenchers this past season has been 800 ft. of pipe per day, including setting all hydrants and making all connections.

Digging Bell Holes

An important item in labor saving was the efficient manner in which the bell holes were dug on the 48-in. pipe trench. These bell holes are formed by widening the trench 1 ft. on each side for a longitudinal distance of 3 ft. and also deepening the trench almost 18 ins. for the same length.

The sides of the bell holes were cut down with slice bars by two men, one on each side of trench in such a way that the earth fell into the conveyer buckets and was elevated by the trenching machine.

The bottom of the bell hole was removed by lowering the digging arm at the proper time. By this method, 2 men with slice bars and 2 men in the ditch cleaning up and throwing dirt into the buckets were able to dig all the bell holes as rapidly as were 15 men digging them by hand.

Handling Large Pipe.

In placing large pipe in trench, three men with a locomotive crane now do the work for which ten men were required formerly when a tripod derrick was used. A light crane with caterpillar traction was desired for this work, but the division has obtained good results with a 4-wheel Orton & Steinbrenner Crane operated on two sections of standard gauge track, the sections being alternately shifted ahead by the crane as the work progresses. The 45 ft. boom of this machine was too long for safe handling of the 48-in. cast iron pipe so the boom was cut down to 30 ft. The ideal machine for handling pipe, which the division hopes to purchase eventually, should weigh not more than 15 tons and be mounted on caterpillars to do away with the work of carrying and relaying track. Such a machine can also work much closer to the trench without danger of causing cave-ins.

Jointing Costs Reduced

The construction gang is supplied with two Zin-Ho gasoline driven air compressors for operating pneumatic calking hammers and these machines have helped to reduce calking costs

LOWERING 48-IN. PIPE INTO TRENCH. ONE MAN OPERATING CRANE AND ONE OR TWO HELPERS HANDLE ALL PIPE. INSERT SHOWS OLD METHOD WHEN SIX OR TEN MEN "RASSLED" WITH THE PIPE.

greatly on large mains, where pipe was jointed with lead. On small pipe lines, metalium has been used to a considerable extent instead of lead as a jointing material. Over 11 miles of 6, 8 and 12-in. pipe with metalium joints have been laid in Chicago in the past two years and frequent tests have failed to disclose any leakage. A recent experiment on a 48-in. line indicates that the use of metalium is as well adapted to large pipe as it is to small pipe and that a considerable saving is made both in cost of labor and material. A section of 3,800 ft. of 48-in. pipe at the end of a new main on Avondale avenue was laid during the last season and all the joints were run with metalium, a lining of bestolyte being inserted before pouring the metalium. The bestolyte lining between the yarn and the metalium, aids in making a tight joint. This 3,800 ft. line was completed early in September. When the pressure was first turned on to this main there was considerable leakage shown, but recent tests indicate that the joints have taken up and there is now no leakage on this section.

Miscellaneous Equipment

Other equipment used by the pipe laying gangs consists of gasoline driven centrifugal pump of large capacity, for pumping out wet ditches, small gasoline driven trench pumps, and a sand-point outfit with a Gould triplex pump for wet sand ditches. Gang "A" is not equipped with machinery for backfilling trenches. This work is let to contractors.

Personnel

Water main construction in Chicago is handled by the

Water Pipe Extension Division of the Bureau of Engineering, Department of Public Works. Mr. Frank I. Bennett is Commissioner of Public Works, Mr. John Ericson is City Engineer, Mr. H. L. Lucas is Superintendent of Water Pipe Extension, Mr. R. S. Spalding is Engineer of Water Pipe Extension and Mr. C. S. Ongman is foreman of Gang "A."

Standardization of Pavement Design and Construction

By Prévost Hubbard, Chemical Engineer, U. S. Bureau of Public Roads, Washington, D. C.

Among the far reaching effects of the world war upon American activities the most noticeable in connection with highway work at this time is that of general restriction. Highway construction is, however, by no means the only industry, if in a broad sense it may be called such, which is subject to restrictive measures. Many essential lines of production have been curtailed to the extent that considerable ingenuity on the part of well organized industries has been required to supply most efficiently the demand for certain commodities. Owing to shortage of labor and raw materials as well as to transportation difficulties and the expense of maintaining large stocks of finished products there has been a marked tendency toward standardization and the elimination of variations and modifications of any given product which depend more upon the individual preference or taste of the consumer than upon the usefulness of the product itself.

General Tendency to Standardize

As an example may be cited the experience of a well known company which manufactures various types of vehicles and normally produces many hundred sizes, shapes and styles of fittings. This company has found it not only necessary but highly advantageous to reduce the number of fittings which it manufactures to less than 60. This means not only standardization of the fittings themselves but of other products in which they are used. Already the results of this policy make its continuance after the war almost an assured fact. Hundreds of other industries have been similarly affected and post war conditions, through keen industrial competition, will in all probability further the general tendency to standardize.

Standardization Insures Quality and Reduces Costs

It may be argued that standardization, if carried to the extreme, discourages individual inventiveness, which is one of the most valuable assets of Americans as a class. Admitting this, there is still much room for improvement in the matter of standardization, which will in no way handicap native ingenuity in attempts to improve old products and processes. This situation is particularly true in connection with the design and construction of certain types of roads and pavements. The highway engineer is not primarily a business manager, but there is no reason why he should not profit by the experience of well managed business enterprises. He is entrusted with the expenditure of huge sums of public money. Present prices for many highway materials are almost prohibitive and will continue to be abnormally high for some time to come. Standardization materially tends to insure quality and reduce cost. He may, therefore, with profit to himself and others, give more attention to standardization than he has in the past.

Standardization of Materials

From the above standpoint highway construction and maintenance divides itself into two parts, materials and methods. Within limits both are subject to standardization. The first through co-operation between the engineer and manufacturer and the second through the action of engineers alone. The standardization of materials is perhaps the more important and at the same time it throws less restriction upon the ingenuity and initiative of the highway engineer. For a number of years various organizations have been at work attempting to standardize both materials and methods used in highway engineering, but progress has been slow and their efforts have not had the support which they deserve from individual engineers. Without in any way belittling the very valuable work already accomplished along this line one fact of considerable importance should not pass unnoticed. In general, efforts to standardize have been confined to individual types of pavement without reference to the relation of the materials specified or standardized for a given type to the same class of materials for other types. Moreover, but little thought has been given this matter by individual engineers in their demands upon various industries manufacturing road and paving materials. From time to time complaints have been made by manufacturers of certain products relative to the unnecessary number and variety of specifications which they are called upon to meet. Many such complaints are well justified, the results of existing demands being needless production costs and therefore high selling prices.

Broken Stone as an Illustration

Of all the materials entering into the construction of roads and pavements broken stone is the most extensively used. It may, therefore, well serve as an illustration. For the past two years the United States Bureau of Public Roads has conducted a survey of stone quarries throughout the country for the purpose of obtaining data relating to the commercial sizes of broken stone actually produced and the demands made upon the industry by engineers. In one instance it was found that owing to variations in the demands of engineers within a very restricted area, revolving screens, with as many as 28 dif-

TABLE I—COMMERCIAL SIZES OF BROKEN STONE

Type of Road.	Coefficient of Wear.	Revolving Screen Openings: 3 in.	2 in.	1 in.	½ in.	¼ in.
Water-bound—						
Bottom course	High or medium		(1)	(2)	(3)	
Top course						
Screenings						
or						
Base or both courses	Medium or low		(4)		(3)	
Screenings						
Cover for Bituminous Surface Treatment—						
Coarse chips	Low or medium				(3)	
or						
Fine chips	Medium or high					(5)
Bituminous Macadam—						
Wearing course	High or medium		(2)		(3)	
Chips						
Bituminous Concrete—						
One size stone	High or medium				(3)	
Chips for seal coat						(5)
Graded Bituminous Concrete—						
Coarse aggregate only	High or medium				(3)	
Chips for seal coat						(5)
Bituminous Concrete (Topeka Type)—						
Stone aggregate only	High or medium					(5)
Sheet Asphalt—						
Binder stone	High or medium				(3)	
Cement Concrete Pavement—						
Coarse aggregate only	High or medium			(6)		
Cement Concrete Base—						
Coarse aggregate only	High or medium		(7)			

TABLE II—SAND GRADINGS

Type of Road.	No.	Total per cent. passing screen or sieve: ¼ in.	20	40	50	100	200	Per cent. by Elutriation
Graded bituminous concrete	1	100	.....	30-70	...	...	10-	..
Bituminous concrete (Topeka type)	2	100	.....	.....	...	...	10-	..
Sheet asphalt binder	3	100	.....	.....	...	...	...	..
Cement concrete pavement	4	100	50-80	.....	20-	5-	...	3-
Cement concrete base	5	100	20-	.....	50-	10-	...	5-

Type of Road.	No.	Per Cent. Between Sieves. Pass 10	10-40	10-20	20-30	30-40	40-50	50-80	80-200	80-100	100-200	Pass 200
		...	12-50	.....	.....	.....	.....	.....	20-40	.....	.....	...
Sheet asphalt	6	100	.....	2-15	5-15	5-25	5-30	5-40	.....	6-20	10-25	5-

ferent size openings were being used to produce broken stone for a comparatively few types of roads. In many cases screen openings varied by only ⅛ in. or less. Among twelve plants in a singe state 22 sizes of screens were used in 37 different combinations to produce to all practical purposes six commercial sizes of broken stone. It is generally admitted that the reason for this lies with individual engineers, who demand certain sizes for a given type of road without reference to other products which the crushing plant is called upon to supply and also without reference to the size or sizes they themselves will require for other types of roads.

Varying Standards Place Burden on Asphalt Industry.

At the recent convention of the American Society for Municipal Improvements a short paper upon "Standardization of Required Consistency for Asphalt" was presented by J. R. Draney, representing one of the asphalt companies. For a comparatively few types of pavement it was shown that engineers were demanding variations in penetrations of from 35 to 190 in a great number of combinations, some with limits of only five points. He stated that the company with which he was connected had been called upon to furnish asphalt with 20 different ranges of penetration for three types of pavements and attributed this fact to lack of concordant ideas, and the result of individual tastes on the part of engineers. From the manufacturer's standpoint he pointed out the extra work, expense, time, trouble and worry which resulted, and called attention to the need for greater efficiency and economy in this matter under wartime conditions.

No Single Standard for Bituminous Materials Desirable

Among the materials used in highway construction Portland cement is the only one of which it may be said that a single uniform standard specification has been generally adopted. This material is, however, peculiar in the fact that its quality may be considered irrespective of the class of work in which it is used, the character of other materials which are to be associated with it, variation in the raw materials from which it is made, and the effect of local conditions, such as traffic and climate, upon its usefulness. No such single standard can or ever will be applicable to most of the other road materials and this is particularly true of bituminous materials. Thus for a bituminous concrete pavement no one grade of asphalt or tar can be specified which will be suitable for all mineral aggregates or all climatic and traffic conditions. The consistency of the material should properly be varied to suit these particular conditions. There is, however, a limit to the number of grades which are actually required and it should be the aim of highway engineers to standardize the minimum number necessary.

Standardization of Brick and Block Well Advanced

Brick, stone block, creosoted wood block and asphalt block are integral road materials, the characteristics of which do not depend upon any other materials with which they are associated in the pavement. Their standardization, with perhaps the exception of the last mentioned, is well advanced, and further improvement in existing standards will be attained without reference to other materials. Broken stone, gravel, sand, oils, asphalts and tars are, however, used in numerous combinations for various types of pavements, and their standardization should be considered first of all from a general viewpoint so as to avoid all unnecessary overlapping or conflict among the special types and grades specified for different uses. It is impossible to develop this subject in detail without entering into a lengthy discussion of various physical and chemical characteristics which are included in modern specifications. The most important features may, however, be illustrated by considering the commercial size or grading of mineral aggregates and the consistency of bituminous materials. For this purpose the typical specifications for road materials recently published as Department of Agriculture Bulletin Nos. 691 and 704 may serve as an example.

TABLE III—TOTAL MINERAL AGGREGATE GRADINGS

Type of Road.	No.	Per Cent. Between Screens and Sieves. 1-½ in.	½-¼ in.	½ in.-10	¼ in.-10	Pass 10	10-40	40-80	80-200	Pass 200
Bituminous concrete (Topeka type)	1	.....	5-10	.....	11-25	.....	7-25	11-36	10-25	5-11
Sheet asphalt binder	II	15-65	....	20-50	.....	15-35	.....	.....	.....	....

Commercial Sizes of Broken Stone

In the latter publication broken stone for all of the common types of pavement are specified upon the basis of laboratory screen tests, but the intermediate gradings and the tolerances for material, retained on the largest opening and passing the smallest opening specified, are so adjusted that the screening plant may readily produce any desired size by using commercial screens with the maximum and minimum openings described for the laboratory screens. Thus plant screens with only five sizes of holes and used in but seven combinations may be made to produce commercial broken stone products suitable for all types of pavements. These sizes

TABLE IV—CONSISTENCY OF BITUMINOUS MATERIALS.

	Asphalts: Letter	Climate	Penetration 25°C	Tars: Letter	Climate	Float test 50°C seconds
Bituminous macadam	a	Northern	120-150	a	Extreme North	90-120
	b	Middle Belt	90-120	b	Northern	120-150
	c	Southern	80-90	c	Southern	150-180
Bituminous concrete (One size stone)	c	Northern	80-90	b	Northern	120-150
	d	Southern	70-80	c	Southern	150-180
Granded bituminous concrete	d	Northern	70-80			
	e	Southern	60-70			
Bituminous concrete (Topeka type)	e	Northern	60-70			
	f	Southern	50-60			
Sheet Asphalt—						
Binder course	e	Northern	60-70			
	f	Southern	50-60			
Wearing course	f	Northern	50-60			
	g	*Southern	40-50			

*Or heavy traffic.

TABLE V—MATERIAL STANDARDS FOR VARIOUS PAVEMENTS.

Type of Road.	Broken Stone	Sand	Port. Cem. or Filler	Total Aggregate	Climate	Asphalt or Tar
Water-bound macadam	1, 2 & 3 or 4 & 3					
One course concrete	6	4	Cement			
Foundations—						
Broken stone	1 & 3 or 4 & 3					
Cement Concrete	7	5	Cement			
Wearing Courses—						
Bituminous macadam	2 & 3				(Northern	a a or b
					(Middle	b b or c
					(Southern	c c
Bituminous concrete (One size stone)	3 & 5				(Northern	c b
					(Southern	d c
Graded bituminous concrete	3 & 5	1	Filler		(Northern	d
					(Southern	e
Bituminous concrete (Topeka type)	5	2	Filler	I	(Northern	e
					(Southern	f
Sheet Asphalt—						
Binder	3	3		II	Northern	(e
Wearing course or Binder		6	Filler			(f
	3	3		II	Southern	(f
Wearing course		6	Filler			(g

numbered for the sake of future reference are shown in Table I.

Grading Requirements for Sand

Standards for sand need not be governed by the same considerations as for broken stone. Sand, being a natural product, is either suitable or unsuitable for a given use. If, as it occurs, it is unsuitable but may nevertheless be used, it will either have to be screened through a single screen or else combined with another sand to produce the desired grading. Sand specifications should, however, be so drawn as to permit the use of as wide a variation as possible without impairing the quality of the work in which it is used. Table II. shows the grading requirements for sand to be used in the types of pavement covered by Table I.

Grading Mixed Aggregates

These specifications are also numbered for future reference. When a sand is to be used in combination with a commercial broken stone product, in which considerable material passing the ¼ in. screen is allowed, it is an unnecessary and confusing restriction to require a definite grading for the sand itself. If in such cases the grading of the mixed aggregate is carefully specified, the specifications will allow the use of any reasonably good sand which can be so proportioned in the mix as to produce the required grading. Grading specifications for such mixed aggregates are given in Table III.

Bituminous Materials

Coming now to bituminous materials the principal consideration is that of necessary limits of consistency for asphalts and tars to be used in the construction of the different types of pavements. The consistency at normal temperature of asphalt is usually expressed in terms of penetration and of tars in the time consumed in making a float test at 50°C. For any particular type of asphalt or tar the limits of other physical and chemical characteristics must be varied somewhat to meet the different ranges of consistency, but these limits need not here be considered. Climatic, and in some cases traffic, conditions will govern the consistency range which should be allowed for a given type of pavement. No very definite climatic lines can be drawn but, considering the country as a whole, three general climatic divisions may be made. These are, northern U. S., middle belt U. S., and southern U. S. In most cases two divisions will suffice, northern and southern. It is understood, of course, that high altitudes and various local conditions will not make the terms northern, middle and southern strictly applicable.

Consistency Limits for Various Bituminous Pavements.

In the case of tars it has been thought advisable to introduce a slight variation in the above classifications and to consider extreme north, northern and southern. Table IV. shows the consistency limits for various types of pavements under different conditions. It will be seen that only seven grades of asphalt and three grades of tar are involved. These have been given letters for the purpose of brief identification.

Tables I. to IV. cover a total of 25 material specifications or general standards, including 7 commercial sizes of broken stone, 6 sand gradings, 2 total mineral aggregate gradings, 7 consistencies of asphalt and 3 consistencies of tars. If to these are added the standard specification for Portland cement and the usual specification for mineral filler calling for limestone or dolomite dust, all passing a 30 mesh and at least 65 per cent. passing a 200-mesh sieve, practically all materials for pavement construction involving the use of broken stone are included. Various combinations of these standards may be used for 9 types of pavement or foundations under such local conditions as will ordinarily be encountered. Table V. illustrates these combinations by means of figures and letters which refer to standards given in the preceding tables.

It is realized that exceptional conditions peculiar to certain problems, which will at times confront the highway engineer, may make it advisable to vary somewhat from the scheme of standardization which has been developed. To the writer's knowledge, however, no attempt at standardization along the broad lines indicated in this article has heretofore been made, and it is hoped that the two bulletins containing the complete specifications, to which reference has been made, will be of material assistance to engineers in standardizing pavement design and construction.

Land Reclamation and Highway Development Must Go Together

By Hon. Franklin K. Lane, Secretary of the Interior, in Addressing the Conference of Regional Chairmen of the Highways Transport Committee, Council of National Defense, Sept. 17, 1918

I did not come today with the idea of bringing you anything new. On the contrary, I have come here to get the inspiration which association with those from the outside gives. There is no hope for this place unless we can keep in contact with the remainder of the United States. In isolation we think in a vacuum, and it is only when we know what you are thinking of on the outside that we get the impulse which leads to construction. I think I can say out of my knowledge of 12 years of administrative work in this city, that we have to look abroad, go up on the tops of the hills and see the great valleys of our country before we know really what our policies should be. When we live alone or live in isolation and try to deal with things abstractly or theoretically, we make mistakes.

Highway Conditions a Measure of Civilization

The problem that you deal with is one that I have never had any contact with, but I know this from my knowledge of history; that you can judge the civilization of a nation, of a people, of a continent, or of any part of a nation, by the character of its highways. If you will think over that proposition you will realize that what I have said is true, that those parts of this nation are most backward, where people live most alone, where they develop those diseases of the mind which come from living alone, where they develop supreme discon-

tent with what is done at Washington or what is done in their own state legislatures, where they are unhappy and discontented, and movements that make against the welfare of our country arise, are those parts where there are poor highways and consequently a lack of communication between the people.

Our eyes are all turned at this time to the other side of the water. I suppose that there has never been a month in the history of the United States when so many people were so anxious to see the morning paper or the evening paper as during the past month. There never has been a time when we have been so thrilled to the very core of our beings. Achievements that those boys over there have made are things that will live in our memories.

What Good Roads Meant to France

And why has it been possible for France to carry on for four years a successful war against the greatest military power that the world has ever seen? Because France had the benfit of the engineering skill and of the foresight of two men who are 1,800 years apart—Napoleon and Caesar. Those men built the roads of France. Without those roads, conceived and built originally by Caesar for the conquest of the Gauls and for the conquest of the Teutons, without the roads built by Napoleon to stand off the enemies of France and to make aggressions to the eastward, Paris would have fallen at least two years ago. So that you gentlemen who are engaged in the business of developing the highways of the country and putting them to greater use may properly conceive of yourselves as engaged in a very farsighted, important bit of statesmanship, work that does not have its only concern as to the farmer of this country or the helping of freight movement during this winter alone, but may have consequences that will extend throughout the centuries.

Take the instance of Verdun. Verdun would have fallen unquestionably if it had not been for the roads that Napoleon constructed and that France has maintained; for all the credit is not to go to the man who conceived and the man who constructed. This is one thing where we have been short always; one thing that the people of the United States do not realize. It is not sufficient to pay $25,000 a mile for a concrete foundation but you must put aside ten cents out of every dollar for the maintenance of these roads or your money has gone to waste and your conception is idle. And you gentlemen know if you continue as I hope you will after the war, you will have not merely a function in the securing of the building of good roads, but will have a very great function in the maintaining of these roads as actual arteries in the system of transportation of the country. You remember that at Verdun the railroad was cut off, and Verdun was supported by the fact that she had trucks which could go 40 ft. apart all night long over the great highway that had been built from Paris to the east.

Railways Alone Do Not Provide Adequate Transportation

Now I saw my first national service in connection with the Interstate Commerce Commission and I was much impressed by the theory that the railroad men had, which was a very natural theory, arising out of their own experience and out of the fact that there was a new force in the world with which they were playing. Their conception was that the highway was a mere means of getting from the farm to the railroad, that the waterway was a mere means of carrying off the surplus waters from the hills to the oceans. The statement has often been made to me that there would never be an occasion when it would be necessary or possible to put into competition with the railroads the waterways of this country; that it would cost more to use those waterways or to use highways than it would to do the same transportation work by railroad. And they had obtained figures to show that under conditions of unlimited competition the Illinois Central, for instance, paralleling the Mississippi river, could do business at a cheaper rate than it could be transported by water, considering the cost of bringing it to the water station and unloading it at the other end. Now, as Mr. Chapin has said, a larger conception has come into the American mind: the conception of the utilization of all our resources. While the railroad has a great burden cast upon it; while it is the strong right arm in this work, still we must remember that the strong right arm must have fingers, and that there should be in a complete physical system a good left arm.

The highways that you are interested in are more than interesting to me for another reason.

Caring for Returned Soldiers

I have thought of the men who will come back after the war. Every nation has had a problem to deal with the returning soldier. If you read Ferraro's history of Rome, you will find that one of the chief reasons why the republic of Rome went out of existence and the empire of Rome came into existence was because of the returned soldiers. They looked to their general to take care of them on their return, and their general found that the way to take care of them was to give them, as they said in those days, "bread and circuses," and so they reached over into Egypt, got the great wheat supply of that country, and provided the great circuses that are historical, for the amusement of those people.

The emperor of Germany ten years ago was asked why he was unwilling to agree to a demobilization of his forces or to a reduction of his army and he said because it would demoralize the industries of Germany. They could not reabsorb so many men without reducing wages and throwing upon the country so many unemployed that it would make against the welfare of the land. We will have that problem to deal with.

The firm, strong position taken by the president in his note published yesterday indicates that he is ready to fight this thing out to a finish and that he will show to those on the other side that America has a determination to win, and that it is not a determination that fades quickly. If the emperor of Germany has ever had a good look at a photograph of Woodrow Wilson he has seen a prolongation of a chin that must have confirmed him in the belief that America does not take up a fight unless it puts it through; and we are to reach a military determination by whipping them until they say they have had enough.

Now when this thing is over our men will begin to come back into the United States. But not all at once. We won't have three or four million men to deal with in a single month. We will have them slowly returning to us through a year or a year and a half. As those men come filtering in through our ports we ought to be able to meet every man at every port with the statement that he does not have to lie idle one single day. We ought to be able to say to the man, "Here is something that you can do at once. If your old position is not vacant, if you cannot go home to the old place and take up the work that you were in, then the government of the United States, in its wisdom, has provided something which you can do at wages upon which you can live well."

Land Reclamation

And what should that be? The greatest problem that any country has, to my mind, is its own self support. We have come to be independent in our resources, to be strong, and be respected. So long as we are industrially dependent, agriculturally dependent, somebody has a lever that he can use in a time of crisis, as against this nation. Long years ago we were the greatest of all agricultural people, and Thomas Jefferson wanted us to remain in that position. He thought that the safety and security of the United States lay in the fact that we would live on farms. When De Toqueville came over here in 1830 he said the reason democracy was a success in this country was because we were all practically living on farms, living on what we raised ourselves, and standing equally.

Today the tendency is away from the farm toward the city, toward industrial life, toward aggregations of people, away

from the small town to the larger town, and from the larger town to the metropolis. People are being drawn from the farms, so that one-half of the arable land this side of the Mississippi is unused today; so that between here and New Orleans there are 40 million acres of land privately owned and unused; so that in the great Northwest, Minnesota, Oregon, Washington, etc., there are 100 million acres of cut-over lands that are practically unused; and we have a new nation practically in the undrained lands of our rivers and our bays and inlets, lands that are as rich as any that lie out of doors, as rich as the valley of the Nile or of the Euphrates. In the far western country there is at least 15 million acres of land that we can put under water. Under water that land produces more than one crop a year, and that an exceptionally rich crop.

We have been extending ourselves because of war in a great many different directions. The government has taken to itself unprecedented and unthought of powers because of the necessities of our condition. I say that to meet the problem of the returned soldier we ought to take advantage of this opportunity to do the work now that must eventually be done and reclaim these arid lands of the West. Turn the waters of the Colorado over the desert of Arizona, store those waters in the Grand river and in the Green river and let them flow down at the right times on that desert so as to raise cotton and cantaloupes and alfalfa. Then come east and take the stumps from these cut-over lands. Do it not as a private enterprise, because that is a slow, slow process. Men are discouraged and disheartened when they look at the problem of pulling an Oregon fir stump out of the ground. It really requires large capital. Then come further east and take these lands that are swamp, that need draining, and build ditches and dikes and put these lands into the service of America. This is what I call the making of the nation.

Good Roads and Rural Express Essential

That land should tie up with all other land. Means of communication should be a part of that general scheme. We should have as good roads between the little farms in Mississippi or in South Carolina or in Northern Minnesota as we have in Maryland or in California. There is a work—the work that I have in mind, and for which Congress has made a small and tentative appropriation—the work of surveying this country and seeing how many of this nation's land resources have not been mobilized and how best they can be used for providing homes for these men who come back, as well as adding to the wealth of the world. There is a work that ties up directly with your work, because I want to have small communities in which men have small acreages of land, not to speculate with but to cultivate; and these acreages are to center in small communities where men can talk together and profit by their own mistakes and their own successes and where those small communities will be tied up with all neighboring communities so that there will be easy access between all parts of the country. Good roads and a rural express must be had. If you can help the government in building good roads for little money or show how a rural express can be most profitably developed, you will be helping in the making of a new America.

And I can conceive of a United States that will be as rich per acre as France; in which the people will be divided into small communities, industrial communities as well as agricultural; for every one of these little places ought to have its own creamery, its own cannery. The farmer is the poorest man in the world to develop any kind of co-operative scheme. He needs assistance and is always hampered by the lack of capital. But now is our chance to see what can be done; to show it in the building of ideal communities, communities that have good houses, that have good sanitation, that are on good land where there is somebody who can direct them as to what should be planted and what should be avoided, communities which may be connected up with the world by highways, by developing rivers and by railroads.

Now, I think if there is one great fault that industrially we have been guilty of in the United States, it has been the effort to develop quantity at the expense of quality. We have been a wholesale nation. We have had a continent that was rich beyond any precedent. We did not know what any acre of our land might produce. A man might go on it out in Oregon and think it was a fir land, think it was good for nothing but timber, and find first that it was the richest kind of dairying land, and find next that it contained a gold mine or a chrome mine. We have never known, and we do not know yet, what the riches of the United States are, and we won't know until we have put study and thought and money into the problem of making this country what it can be by the application of thought, energy and investment.

A Changed Nation

The United States is not going to be after the war as it has been. That is a thing that you sober men of business are already thinking about. We are never going to return to the idea that was. The man that comes back from this war will be treated by us with distinguished consideration, because he has taken a risk that we have not taken; that we have not had the opportunity to take, I am sorry to say. But that man is going to insist upon larger opportunity for himself, and the largest opportunity that he wants is an opportunity to make himself independent, and he is going to have a conception of a social America that we have not had. This war is a leveling force. When we adopted the draft, under the leadership of Senator Chamberlain we did a thing that was of the deepest and most far-reaching consequence. We did a thing that put the millionaire's boy and the lawyer's boy and the cabinet official's boy alongside of the bootblack and the farmer and the street car driver. It was the most essentially democratic thing that this country has ever done, and the spirit of the draft is going to continue after this war. Those boys are always going to look upon each other as brothers in arms, sympathetic toward each other.

We men who are in politics today have seen our day. They are going to take charge of the politics of the United States. They are going to take charge of the social problems. They are going to insist upon industrial as well as social equality. We know that this does not necessarily mean that the nation must be run by them because they were soldiers, not unless they have the quality that gives them foresight and good sense. But now we should prepare for them. We must realize that these men are all comrades, that they are going to work together, and we ought to spread this feeling throughout the entire country. The fighting men themselves ought to get the feeling that we have who have been left behind are also in the service of the country trying to do something large for the making of this nation along real lines.

You know that there is a big man and a little man in each of us; and the little man had his day. He was the selfish, egoistic, narrow, money-making fellow. Just as soon as this country went into the war the big man came out. The big man inside of us was challenged and he arose at once and responded. And so we found railroad presidents and bankers, the automobile men and the business men of the country coming down to Washington and saying, we want our opportunity to help. It was not selfish: it was noble. And that spirit if carried out will make this country a new land in which these boys who come back will find they have been cared for; that helpfulness has come to take the place of indifference and co-operation to supplement individual initiative.

Snow Removal from Highways

The Highways Transport Committee of the Council of National Defense, which co-operated last winter with various state highways departments in the removal of snow from motor convoy routes extending over north and middle western states to seaboard, is now preparing to undertake this impor-

tant work during the coming winter. The aid of the highways transport committee has been asked by Col. Charles R. Drake, chief motor transport corps, U. S. Army. This again has served to focus attention on the desirability of keeping snow cleared off highways used for transportation purposes.

The state highways officials of Illinois, Pennsylvania, New York, Ohio, Indiana, Michigan, New Jersey, Massachusetts, Connecticut, Delaware and Maryland, which co-operated with the highways transport committee and the War Department most effectively last winter, will be called upon again to aid in planning the snow removal program now being arranged.

Keeping Connecticut Highways Open in Winter

Procedure in the removal of snow from Connecticut highways is described as follows by W. Leroy Ulrich, superintendent, Connecticut State Highway Department, writing in the *Concrete Highway Magazine:*

USING THE MARTIN DITCHER AND ROAD GRADER TO REMOVE SNOW FROM GUTTER TO FACILITATE RUNOFF OF SNOW WATER.

The necessity for the removal of snow from the highways of Connecticut has been recognized in a small way for many years, it being the duty of the towns to keep all roads passable. But this resulted in little benefit.

As early as the winter of 1916 plans were made by the State Highway Department to experiment on the removal of snow from the most important trunk lines. These plans became necessary because of the increasing truck traffic and the disastrous results of this traffic when confined to one or two sets of ruts, due to the accumulation of snow and ice. Under these conditions ruts were worn into the surface, which were very expensive and difficult to repair and could not be removed entirely.

Experiments carried on during the winter of 1917 showed that the formation of these ruts was practically prevented by the removal of snow, decreasing the cost of bituminous repairs the following spring by at least one-third. Traffic on these roads during the winter months showed only a slight decrease in the normal use of auto trucks. Such good results were obtained that the legislature of 1917 passed an act obligating the State Highway Department to remove snow from trunk line highways.

To carry out this work the department planned to use 18 snow plows attached to the front of its trucks. Due to the severest winter condition known for 20 years, these proved inadequate, and tractors and road machines of all kinds were used. The snow plow equipment is being increased by the addition of 20 more plows for use on the front of the trucks.

The work was successful. At no time were any of the trunk lines blocked for more than 20 hours, and usually normal traffic conditions prevailed the morning following the end of the storm.

On routes heavily traveled by trucks practically all the snow was removed, while on roads with a mixed traffic the snow was removed so that not more than 3 ins. remained.

Some complaints were received on account of the inability to haul by sleds, but the necessity for moving great quantities of war and industrial materials, which could not be moved except by motor truck, fully justified this procedure and the expense involved. Figures as to the cost of the work are of little value on account of the varying nature of the country and the amount of snow fall.

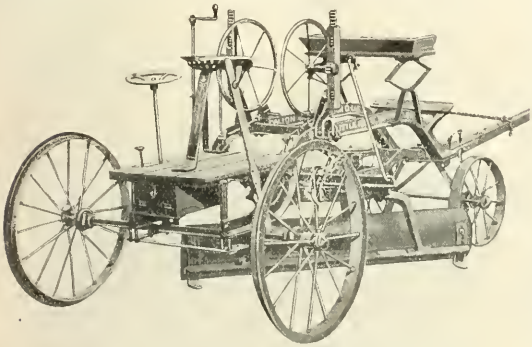
CHAMPION SNOW PLOW ATTACHED TO A GARFORD MOTOR TRUCK.

Representative Equipment Available for Snow Removal

Road-making and maintenance machinery regularly employed on the construction and repair of roads in the summer are effectively utilized in many localities as snow removal machines in the winter. For example, the several types of road machines manufactured by the Austin-Western Road Machinery Company (Chicago) have been used very successfully in removing snow in Chicago and elsewhere. These machines handle snow of moderate depth, but are not adapted for use in removing a very heavy fall of snow. Again, a great many Russell blade graders (Russell Grader Manufacturing Company, Minneapolis, Minn.), especially the Simplex type of grader, have been used for removing snow. Several of these machines were purchased by American and Canadian cities for snow removal purposes.

Several types of snow removal machines are manufactured by F. C. Austin Company, Inc., Chicago. The Austin machine for handling heavy snowfalls consists of a large plow mounted on the front of a multipedal tractor. The Austin machine for light snow moving is a V-shaped tool which can be used as a road drag in the summer. Another Austin machine is a snow-melter designed for use in connection with shovelers.

Herewith is shown an illustration of the use of the Martin ditcher and road grader (Owensboro Ditcher and Grader Company, Owensboro, Ky.) in removing snow from a gutter. This procedure opens up the channel of surface drainage so that water released by the melting snow can flow to the gutter inlets. Many cities have purchased these machines for snow removal purposes. S. F. Miller, of Winona, Minn., reports that in 6 hours, with one of these machines, two men and a team, he cleared the road for a distance of one mile and to a width



THE GALION SNOW PLOW AND GUTTER CLEANER.

of 15 ft., so that an automobile could go through. In some places the snow was 4 ft. deep, with a hard ice crust. He broke the crust with a disc harrow, then used the Martin, equipped with the snow blade.

The Galion reversible snow plow and gutter cleaner (Galion Iron Works and Manufacturing Company, Galion, O.) is illustrated herewith. This machine removes snow and slush from gutters, roads and walks. A machine of this type will obviously do the work of scores of snow-shovelers at a greatly reduced cost.

There is also illustrated herewith the Champion snow plow (Good Roads Machinery Company, Inc., Kennett Square, Pa.) attached to a motor truck. This machine was introduced three years ago and is now in use in many northern and western cities; over 200 are owned by the city of New York. Many are owned and operated by state highway departments. This snow plow can be attached to any standard motor truck. It is handled by one man. It is much used in keeping open the main highways, where motor truck traffic is heavy in the intercity and interstate haulage of freight.

Recommended Procedure in the Use of Explosives on Road Construction

The building of modern roads often proves to be more costly than necessary. Reductions in the cost of building are effected by good location and a rational use of modern road building supplies and machinery. Deep cuts and high fills should be avoided when possible and locations that are hard to drain should be shunned. In excavating, the dirt or stone should be loosened by blasts to avoid the high cost of picking and ineffective plowing; for short hauls scrapers will remove the necessity of loading on wagons or carts; stumps, boulders, and ditches should be blasted; and steam shovels, scrapers, road machines, drags, and other labor-saving machinery should replace hand labor wherever possible.

Satisfactory drainage is the first essential of good roads. No matter how much attention is given to the grade, location, and surface, no road will give satisfactory or permanent service that is located on a shifting, wet, or inadequate foundation or subgrade. Unsatisfactory foundations are usually caused by wet or poorly drained spots. Where these cannot be thoroughly drained and firmed they should be avoided by a change of the location of the road.

More roads fall into bad repair through poor subgrades than through all other causes combined. More bad subgrades are due to poor drainage than all other causes combined.

Clearing with Dynamite

Before putting the graders to work at surfacing or cutting, it is necessary to have the brush, trees, stumps and boulders well out of the way. The quickest and easiest way is by the use of dynamite, and a little practice will enable the blaster to get rid of these in a most satisfactory and economical manner. The stumps and as many roots as possible, should be blown out and shattered so that they can be handled easily.

For small stumps with lateral roots the most satisfactory loading is to drill or bore a hole under the main body of the stump, or if it is a one-sided affair, under the part that will be hardest to lift, and load it with a sufficient amount of dynamite, about 40 per cent. strength.

Size and Location of Charge for Small Stumps

Try one of the smaller stumps first and govern the other charges by the results obtained. If the trial stump is a green one about 12 ins. in diameter in a clay subsoil, begin with two cartridges. If that proves too much or too little, vary the next charge accordingly. Wet soils will require less dynamite than dry soils, and heavy soils less than light, sandy soils. Such a charge must be tamped in well and may be fired with either cap and fuse, or with an electric blasting cap.

In blasting out a small stump the charge of dynamite should be well below the bottom of the stump so as to leave a sufficient volume of earth above the dynamite to spread the lifting force of the explosion over the whole area of stump cross-section. By placing the charge too close, the effect is to split the stump and leave the larger roots still hanging in the ground.

Large or Hollow Stumps

Such loading as has just been described will not be sufficient for large or hollow stumps. Where these are found the charge should be distributed around and under the stump as is shown in Fig. I. It is absolutely essential that each of the small charges be fired at exactly the same time, so an electric blasting cap must be used with a blasting machine. On account of the variability of stumps and soils, definite charges cannot be given for stump blasting, but a few trial shots will give the blaster a good idea. Selecting a solid green stump about 30 ins. in diameter, a good test shot would consist of six to nine cartridges placed in three or four holes, each hole put down to a depth of from 3 to 4 ft. The kind of dynamite to use is the same as for blasting small stumps.

Heavy Tap-Rooted Stumps

The loading for blasting heavy tap-rooted stumps similar to the southern pine must be varied to conform to the difference in roots. There are two well-established methods of loading these. One method is to expose the tap root to the desired depth and then bore more than half-way through it with a 1½ or 2 in. auger. The charge should be packed tightly into the hole and securely tamped. Two or three cartridges will usually be sufficient to blow out tap-rooted stumps 12 to 15 ins. in diameter.

The other method is to surround the tap root with two or more holes bored downward through the soil immediately alongside the tap root. These holes should always be at least 3½ ft. deep, and where it is desirable, as in cuts, to get all of the tap root out, it may be necessary to go several feet deeper, as these roots are often 8 or more ft. long. Electric caps are essential in getting the charges to fire simultaneously. The last method of blasting tap-rooted stumps requires more explosives but less labor than the first one, and is more generally used by road engineers.

Handling Boulders

Most road builders experience much difficulty in handling heavy or hard boulders in road building. The trouble usually comes from an improper selection of explosives, or from faulty loading. Either trouble can be easily overcome by a little study and practice and the boulders can be handled at will.

A hole may be drilled approximately half way through the stone and loaded with any grade of high explosives. The hole must be well tamped. This method requires the most labor but the smallest amount of explosives. It is well suited to shattering large or very hard boulders.

The dynamite should be packed well in the bottom of the

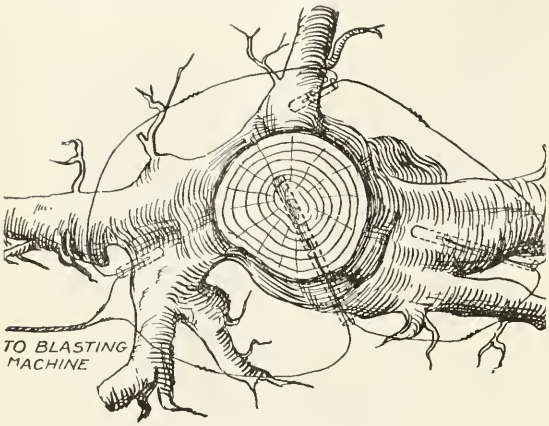


FIG. 1—METHOD OF LOADING LARGE STUMP FOR ELECTRIC BLAST.

hole to prevent the leaving of any air spaces. If necessary, it may be removed from the paper shell or wrapping, and the hole firmly tamped. In firing the holes care must be taken to avoid flying rock fragments. Blasting mats or barricades should be used when blasting in the vicinity of houses.

A hole may be punched or drilled under, but immediately against the bottom of the boulder, and loaded with extra dynamite, 30 per cent. or stronger. This method requires an intermediate amount of labor and explosives, and is especially adapted to blasting all classes of boulders where one of the other methods is not specifically recommended. It is often used to roll large boulders out of the way without shattering them. Good tamping is essential.

Frequently large sunken boulders are rolled out on top of the ground by snakeholing and are then broken up by mudcapping.

Mudcapping

Mudcapping is the only method of boulder blasting requiring neither drilling nor punching holes. It consists of selecting the place on the boulder where it might be broken by a blow from an enormous hammer, and packing thereon a sufficient amount of 50 per cent. straight dynamite (first removing it from the shell), or if there is but little work of this nature to do, a slightly larger amount of straight 40 per cent. dynamite, and covering it with a heavy layer or moist clay or soil. For some of the softer and more easily broken flat-shaped boulders extra dynamite 40 per cent. gives good results. This covering should not be less than 6 ins. in thickness. Such a shot may be fired with cap and fuse or with an electric blasting cap. Where two or more mudcaps are used on the same boulder, electric blasting caps and blasting machine must be used. This method is particularly applicable on flat or easily broken rock, but should not be used on large "niggerhead" boulders. The loading is shown in the diagram, Fig. 2.

Care should be taken not to have any stones in the mud or to lay any rocks or chunks on top, for the force of the blast will throw them with the velocity of bullets.

Removing Ends of Outcropping Ledges

When the ends of outcropping ledges form "Thank-you-marms" or bumps, explosives are essential for their removal. The top soil, if any, should be shoveled off, and a hole drilled into the top side of the ledge. This can be loaded with a small amount of any high explosive that may be on the job. If the ledge extends entirely across the road, better results will be obtained by drilling and loading a line of holes all the way across the road and firing by the electrical method.

Very often this outcrop of rock interferes with making a road of proper width, as in side hill cuts, and must be blasted off.

Removing High Sides

The existence of a high side is a very common road trouble. A protruding ledge, boulder or bank of hard clay raises one side of the road so high that travel is slow and painful. Heavy loads cannot be hauled and all vehicles are subjected to unnecessary strain. The method of loading is graphically shown in the accompanying sketch. If the protrusion does not come far into the road, a hole, or row of holes drilled at the point "B" in Fig. 3 and loaded with light charges will be sufficient to break up the material. If the width of the protrusion is too great to be broken by loading at "B," then other holes should be drilled at "A" and fired before the holes at "B," so that the toe of the ledge may be shot off first to relieve the heavy burden against the blast further back. For this work extra dynamite 40 per cent. is the explosive recommended. The charge should be pressed tightly into the bottom of the bore hole and tightly tamped. Where such a high side continues for some distance along the road, one charge cannot be depended on to loosen a sufficient amount of the hard material, and several holes must be placed in line. For such a blast, electric firing is preferable.

Utilizing Stone Fragments

The fragments of blasted boulders and rock ledges can be made to form an important part in the economy of construction. Good, substantial masonry culverts, small bridges and

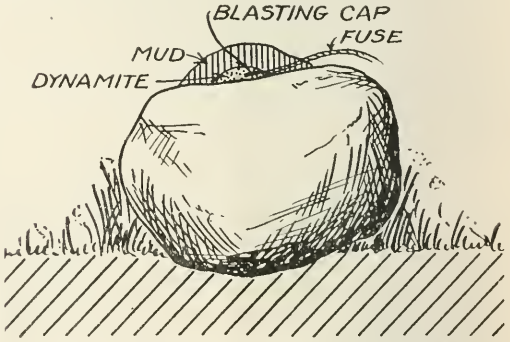


FIG. 2—CORRECTLY PLACED MUDCAP. THE MUD COVERING SHOULD BE SEVERAL INCHES THICK.

bridge piers can be built. Gutters and side drainage ditches can be paved to check wash and erosion on steep grades. Retaining walls on cuts and fills and guard walls or fences, where there is danger of traffic plunging or skidding down steep and dangerous embankments, may be constructed. They can be used in rip-rapping where there is danger of streams cutting into the road, or as a basis for the foundation of the subgrade when crossing sand or wet, soft ground and in making blind road drains. When run through a crusher they can be made to form a substantial part of the crushed stone in

the macadam surface, or can be mixed with sand and cement to form concrete foundations, surfaces, culverts, bridges and walls.

It is often possible to secure a supply of surfacing material at a very small cost by arranging with farmers along the right-of-way to blast out and clear their fields of boulders.

Drainage

By far the greatest feature in road improvement is drainage. No matter how well graded a road may be, or how perfect and smooth the surface, if the drainage of the foundation is not good the road will soon be full of holes. If the side

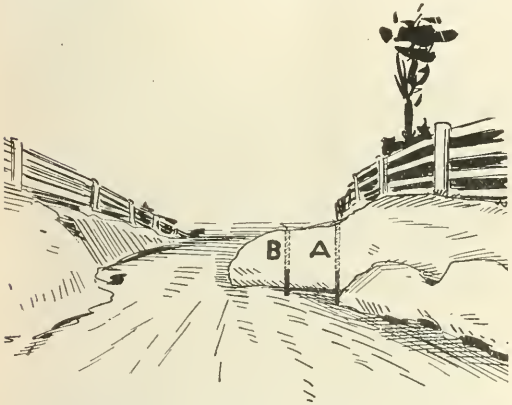


FIG. 3—METHOD OF LOADING. FIRE "B" BEFORE LOADING "A."

ditches are inadequate and flood water is permitted to flow along or across the road, rough spots and little gullies will soon be washed even in the hardest macadam surface.

The crown of the road should be well arched or rounded so that it will shed rain water rapidly. This is imperative on all kinds of surfacing material, but more so on materials like sand-clay, light macadam, and soil surfacing that permits water to soak slowly through to the foundation. The height of crown at center varies with the grade of the road and the character of the surface. On steep grades the slope of the crown should be more than on flat grades. Too high a crown is dangerous as it causes skidding.

A good illustration of a well-arched surface is shown in the illustration, Fig. 4. Such a surface sheds the water immediately into the side ditches, and the roadway proper is dry within a short while after the rain has stopped. Millions of dollars are lost annually by depreciation in roadways due to bad surface drainage.

Roads should always have two good side ditches, the capacity of which will depend on the amount of water to be discharged. On side hill cuts one ditch on the inner side and one along the upper edge of the cut bank to prevent wash into the road are required. Their duty is to collect and discharge the water that is shed off of the road surface and from the side slopes of cuts, and often to receive and discharge large amounts of water received from surface drains from adjoining fields or hills. Careful attention should always be given to providing a suitable outlet for side ditches.

Ditching

In easily worked soil these may be dug by loosening the soil in the ditches and crowding it toward the center of the road with an "A" crowder or road machine. Where the material is harder, the soil is loosened and may be blown out by shallow vertical holes punched along the line of ditch and charged with small amounts of dynamite. Such holes in dry soils should be deeper than the desired ditch and, depending on the depth, can be spaced from 2 to 3 ft. apart. In wet soils the spacing should be about the same, but the depth of holes can be from 6 to 8 ins. less than the depth of desired ditch. Detonation should be by means of electric caps. The soil can then be carted away or crowded to the center of the road.

Where a wider ditch is wanted two lines of holes may be used. The ditches may be made both wider and deeper by driving deeper holes and using heavier loading. Where the holes stand half full of water no further tamping is necessary, otherwise they should be thoroughly tamped.

When the roadway is through wet, swampy land, the methods of blasting are slightly varied to conform to the local condition.

Side ditches on hill roads are often reduced in efficiency by large boulders or outcrops of stone or stumps that were not removed when the road was originally made. These should be blasted out, as they cause the ditches to overflow during rainy seasons and serious erosion results. Where the boulders are loose, they can be easily removed by the snake-hole method as previously described; but where the trouble is from an outcropping ledge, the stone should be drilled and loaded.

Permanent or intermittent trouble from soft and swampy roads is usually found where roads cross shallow streams or swamps. The trouble arises from the stream channels being either too small or too shallow. The only permanent relief is in ditching under, and a sufficient distance below, the road to drain the water away.

Where such ditches are to be through wet, saturated soils, the best method of blasting is to load 50 per cent. straight dynamite in holes 18 to 24 ins. apart and at a depth usually a little less than the desired depth of the ditch. Such a line of holes may be several hundred yards long and is fired by a single cap placed in one hole, the shock or concussion and detonation being carried from one hole to the next almost simultaneously due to the sensitiveness of this grade of dynamite.

FIG. 4—ROADWAY WELL ARCHED FOR DRAINAGE.

The greatest handicap to this type of blasting is temperature, as it cannot be used in weather colder than about 50° F., on account of the straight dynamites being high freezing and becoming less sensitive to shock when chilled.

Cold Weather Ditching

When the weather is cold or the ground dry, so that the above-described method will not work, the holes are punched further apart and loaded with a low-freezing explosive. Each individual charge must be primed with an electric blasting cap, so that the entire charge consisting of a number of holes may be fired at one time by means of a blasting machine. For small ditches, extra 30 per cent. dynamite will give good re-

sults, as they excavate a small ditch at the least cost per running foot, but for ditches larger than 5 ft. wide and 30 ins. deep the cost will be reduced by using extra 40 per cent. dynamite, or, in light, sandy soils, gelatin 40 per cent. The extra dynamites are not so water resisting as the gelatin, hence when the charges must be left for a long time in water-soaked soils before firing, the gelatin is preferable.

A single row of properly charged holes can usually be depended on to blast out a ditch from 1½ to 4½ ft. deep and from 4 to 7 ft. wide in dry soils and 5 to 9 ft. wide in wet soils. When wider ditches are required it is best to load two or three parallel rows of holes spaced about 3 to 4 ft. apart and fire them at the same time. Deeper ditches can be blasted by first opening a wide ditch 3 or 4 ft. deep and then loading a single row of holes in the bottom of it. This method has resulted in giving ditches up to 18 ft. wide and 8 ft. deep, but it is not ordinarily advisable to attempt ditches deeper than 6 ft.

The advantages of blasting this class of ditches are: the saving in cost, the ability of explosives to ditch even under water and through root-bound soils, the little time required for the work, lack of need for expensive equipment that may be used again, and the saving in cost effected by not having to move heavy and cumbersome machinery long distances.

Blind Drains

Some subsoils do not form a good foundation for a road because they absorb and hold too much water, thus making the subgrade so springy that the surface is soon broken up. Similar conditions are produced by springs under the surface of the road. Relief can be obtained by the use of a blind or covered drain laid at the side of the road with branches running across and under the subgrade. Frequently side ditches have branch blind drains leading under the subgrade. The depth of such blind drains should be not less than 2 ft., and preferably 30 ins.

They may consist of drainage tile or loose broken rock piled into trenches. The tile is more substantial and satisfactory, though generally somewhat more expensive.

It is much better practice to lay the main tile line parallel with and at the side of the road with branches at intervals leading across and under the subgrade than to lay the line along and under the center of the road. The first cost of the latter method is somewhat less, but in case of any repairs being necessary the whole center line of the road is disturbed and the surface practically ruined.

When crooked or shallow streams are parallel or crossed it is often cheaper to correct the stream than to elevate the road to a sufficient height to keep it out of trouble.

Stream Bed Changes

When all the excavating for a stream bed for permanent control of the water is done by artificial means, the expense mounts up rapidly. Equally good results may be obtained with much less expense by undertaking the work in a slower but more systematic way, which will permit the stream to do most of the actual digging itself.

A great part of the filling up of stream courses is caused by logs and other floating material forming rafts and sand bars in the channels. Another fruitful source of trouble is from outcrops of rock which divert or impede the normal flow of the current. Overhanging stumps and trees along the banks lend still further obstruction. Sharp bends in the course of the stream check the current and cause trouble by forming sand bars.

Any and all of these troubles may be overcome quickly and at reasonable cost by the use of dynamite for shooting out the rafts and logs, and blasting a sufficient channel through the confining rock. A well-placed blast will remove the overhanging stumps.

The cutting off of sharp turns in the channel will take a little more time and should be well done in the beginning. Locate the line of the new cut-off and blast a ditch that will at all times carry a part of the flow. When this is done and the rafts and logs are out of the way above and below, all there is left to do is to wait for the heavy rains to flood the streams. The increased velocity of flow will cause the water to cut and wear away at the bottom of the channel as well as at the sides. From time to time it will be best to go over the stream and make sure that no new obstruction is being formed.

Small blasted ditches have been scoured out by the current until they are now carrying the entire flow of large streams. With a little help now and then any stream with a fair fall can be made to do wonders in making itself a permanent and suitable course.

Sometimes roads must parallel streams for considerable distances, where the lay of the land is such that the road must be immediately alongside the stream. Correction lies in deepening the stream by blasting, and then constructing a small side ditch next to the bank to handle the water from above.

Blasted boulder and stump fragments and logs of trees from the right-of-way make excellent material for riprapping the side of the road next the stream to prevent undercutting.

Prevention of Longitudinal Cracks in Hard Surface Pavements

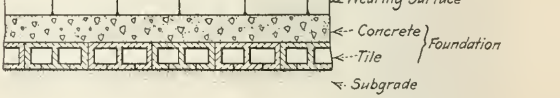
By Wm. C. Perkins, C. E., Chief Engineer Dunn Wire-Cut Lug Brick Co., Conneaut, Ohio

Can longitudinal cracks in hard surface pavements be prevented? Many brick and concrete pavements, especially in northern latitudes, develop unsightly cracks along the center line of the pavement, which mar otherwise good pavements. These cracks may not lessen the durability of the pavement, and they are easily taken care of at small expense; but they are defects which we should endeavor to overcome by improved constructional methods, said Mr. Perkins in a paper before the American Society of Municipal Improvements, which follows:

The study of longitudinal cracks in hard-surface pavements has evolved several theories of causes. The generally accepted theory is that of pressure exerted against the underside of the artificial foundation by the freezing of water in the underlying sub-grade. Undoubtedly other conditions, such as traffic or soft sub-grade might be either an efficient or a contributory cause of cracking; but in my opinion 90 per cent of longitudinal cracks are the result of frost heavage.

Pavement Underdrainage

How can this frost action be prevented? We have said in the past, "Drain! drain! drain! and more drain! Keep the subgrade dry"; and in our endeavors to keep subgrades



TILE UNDERDRAINAGE FOR PREVENTING LONGITUDINAL CRACKS IN PAVEMENTS.

thoroughly dry we have cross-drained, drained longitudinally, herring-bone drained and drained the taxpayer's pockets, yet we have longitudinal cracks, many times directly over our elaborate system of drainage.

Underdrainage is unquestionably advantageous in lowering the water table, but present methods fail to keep subgrades dry, particularly in clay soils and in soils susceptible to capilarity. While our present drainage system does not prevent cracks due to frost action, it does tend to prolong the life of pavements; nevertheless, in spite of drains a certain amount

of water reaches the subgrade underlying and supporting the artificial foundation, and successive freezing and thawing, especially in the early spring of the year, causes upheaval of the subgrade. As explained in a recent article, as the pressure cannot go downward on account of the frozen ground, it must extend upward. This upward thrust breaks the pavement.

We do not know exactly how the pressure acts. We have not enough data on the subject to warrant positive conclusions. Undoubtedly, after the war, when engineers will have more time for research work, tests will be made to determine exactly how the upward pressure acts and how the resultant forces are distributed through the pavement. All we really know now is the result—a pavement cracked, usually along or near the center.

Evidently the remedy must be found in a foundation design. Can we construct a foundation which will, either entirely or in some measure, overcome the destructive action of frost?

Suggested Foundation Design

As a means of accomplishing this purpose I suggest a foundation constructed as follows:

Upon the earth, or prepared subgrade, lay a course of two-duct tile 4 ins. in height, outside measurement. The surface measurements could be any standard size, but I would suggest 8½ ins. wide by 12 ins. long. They may be made of any desired material, such as concrete, vitrified shale or clay, and of any shape or form.

Complete this foundation with 2 or 4 ins. of concrete or other suitable material. We have then prepared a 6 to 8 in. foundation upon which to place our wearing surface of any standard paving material—brick, block, concrete or bituminous.

How Tile Reduces Upward Pressure

By the use of the tile in the artificial foundation, we endeavor to minimize the force of the upward pressure of a frozen subgrade.

(1) The tile acts as a non-conductor of heat between the ground and the paving; the air within the ducts of the tile serving as a non-conductor prevents the extreme cold or frost from penetrating through the pavement of the subgrade; and also prevents the escape of heat from the earth. In many sections this type of construction may prevent actual freezing of the subgrade, while in extreme northern sections it will materially reduce the freezing.

(2) When the earth, or subgrade, does freeze, notwithstanding the heat insulation of the tile, and that the force, or explosion, would be compensated by the air space and not be transmitted to the paving above. In case the tile be too strong to break under pressure of a frozen subgrade, the bottom of the tile, under the air spaces, could be "scored," thus providing a weak spot to break under this upward pressure. The superfoundation and the wearing surface would be sufficiently strong to bridge over any breakage of the bottom of the tile under the air-space sections, since the walls and partitions of the tile would remain intact and would afford ample support to the superfoundation.

(3) The tile would also act as drains to carry off any ground water or water drawn into them by capillary action, thus lessening the hazard of cracking due to the upward force exerted by frost in the subgrade.

Laying the Tile

The tile may be laid longitudinally, transversely or diagonally.

If laid either transversely or diagonally, the water would be carried to the curb or edge, where it can be taken care of by means of longitudinal drains or French drains of gravel or stone.

If the tile are laid longitudinally the water can be taken care of at regular intervals by cross-drains of tile or by French drains of gravel or stone.

The grade and cross-section of the improvement would determine these details.

It is difficult to estimate comparative prices in these abnormal times, but basing estimates on available data, the 4 in. tile should not cost more than 4 ins. of concrete in place, and if constructed as suggested the tile and concrete foundation should be able to carry at least the same load as if the foundation were entirely of concrete or of a material of equal load-bearing strength.

The type of foundation I have suggested as a means of preventing longitudinal cracking of hard surface pavements is the result of study and experience, and while it has not been subjected to the final test of practical service under all kinds of climatic and traffic conditions, I have sufficient faith in its utility for the purpose designed to have the type of construction protected by patent.

Restoration and Extension of Water Transportation in the Illinois Valley

By W. L. Sackett, Superintendent of Waterways, Illinois Department of Public Works and Buildings, Springfield, Ill.

In 1915 the State Legislature, upon recommendation of Governor E. F. Dunne, passed a law authorizing the issuance of $5,000,000 in bonds for the construction of what was termed a deep waterway from Lockport to LaSalle, utilizing the Des-Plaines and upper Illinois rivers. The law indicated the general engineering plan to be followed.

Adverse Ruling of War Department

Under the Rivers and Harbors Act of 1899, before any construction work for the improvement of rivers, or other navigable waters, can be undertaken, it is required that a permit from the Secretary of War at Washington be secured. In June, 1915, Governor Dunne made application for approval of the proposed plans to the Chief of Engineers at Washington for the purpose of obtaining the necessary permit from the Secretary of War. In November of 1916 the application was referred to Col. W. V. Judson, U. S. Engineer then in charge of the Chicago district, for the purpose of a hearing and full inquiry into the entire situation. A number of amendments were offered to the engineering plan in the report of Colonel Judson, and also in the reports of other federal engineers. The chief of engineers refused to approve the plans, and, therefore, the Secretary of War refused to issue the necessary permit for the construction of this waterway. Litigation also intervened to prevent progress upon the proposed plan.

Change of State Administration

In July, 1917, when Governor Lowden's department officials took charge of administration work, it was found that no engineering plans had been developed that in any way changed the situation from what it was at the time of consideration by the chief of engineers at Washington and the refusal of permit for construction. Further, it was found there were no plans developed upon which bids could be asked or contracts let, although for several months the general public had been led to believe everything was in readiness for actual construction upon the waterway by the canalization of these rivers.

Getting Ready for Construction

In November, 1917, the state employed Mr. M. G. Barnes as consulting engineer on this project. Mr. Barnes had recently been connected with the completion of the Erie canal and had experience in the construction of the Hennepin canal, and also designed the structures for the Panama canal. The co-operation of federal engineers was invited. Since that time these engineers have been at work upon developing details of plans necessary for an intelligent consideration of the project by federal authorities at Washington. It has developed that several amendments to the state law are also desirable. It is the hope of the Department of Public Works and Buildings, Division of Waterways of the State, handling the situation, to

overcome the various difficulties presented in this problem during the coming winter, so that everything may be in readiness for actual construction after the conclusion of the war.

Rehabilitation of Illinois and Michigan Canal

In February, 1918, at a conference of advocates of more adequate waterway facilities down the Illinois valley with Governor Lowden and state and federal engineers working on the development of plans of this waterway, these engineers indicated that a very desirable preliminary to the construction of a larger waterway would be the rehabilitation of the Illinois and Michigan canal, especially from connection with the sanitary district channel at Lockport, to La Salle. It was indicated that this canal could not only be utilized in necessary transportation of material for the proposed larger project, but that during the present period it could be of immense value as a transportation factor during the emergency of war. In the best days of navigation on this channel it was able to transport a million tons of freight in a season—equivalent to a saving of approximately 20,000 freight cars.

As a result of this conference the superintendent of the Division of Waterways of the State interested authorities at Washington in this proposition, with the result that an allotment of $150,000 was made for the purpose of this improvement. Actual work was authorized June 3, 1918. Supervision thereof was delegated to Col. C. S. Riche, U. S. engineer at Chicago. Structures along the canal were found in bad condition. The work of repair and reconstruction was pushed and all were put in first-class shape within 90 days. The water was out of portions of the channel and the removal of fills at various points was undertaken by teams and scrapers. On the 1st of September work had progressed to such extent that a good channel was afforded between Chicago and Ottawa. West of that point, however, the channel was restricted by a number of bars and fills, and dredging was delayed to some extent by inability to get the proper equipment for the work. Work, however, is progressing favorably at this time, and boats with draft of not more than 4 ft. can be handled throughout the entire canal. The dredging and improvement are to continue, however, to provide a greater bottom width of channel, and before the opening of the navigation season in the spring of 1919 it is expected the work of restoration of this old canal will have progressed to such an extent as to afford approximately the original navigable depth of water throughout most of its length.

Money for Canal Boats

While this work has been in progress advocates of water transportation through the Illinois valley to connect Chicago with the Illinois and Mississippi rivers have organized corporations to provide boats, and the federal government has also allotted money for the construction of boats which are now in use upon the Mississippi river. The government has promised an allotment of money for boats on the Illinois river. More tonnage is waiting transportation than can possibly be handled through the Illinois and Michigan canal, even if restored entirely to its former capacity, but it will serve a temporary useful purpose in relieving transportation congestion until a larger and more adequate waterway can be provided.

Project of National Importance

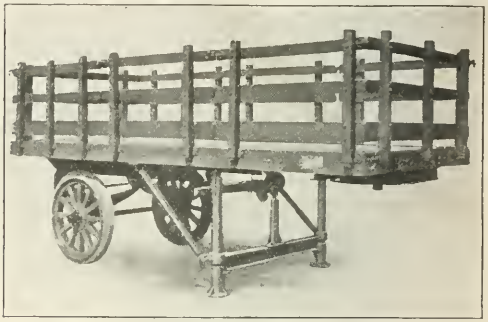
The state is at present considering plans for the larger waterway from the standpoint of its national importance in connecting the inland waters of the country with the east and west coasts, rather than as a local enterprise of value. With sufficient depth of water and adequate locks through this stretch of country, direct water transportation can be had from New York City up the Hudson river, through the Erie canal, through the Great Lakes to Chicago, and from Chicago, through the Illinois and Mississippi rivers, to New Orleans. By utilizing the Hennepin canal these shipments can be sent across the state to Rock Island and thence north to Minneapolis and St. Paul.

New Line of Trailers

A line of trailers, both of two and four-wheel type, and including models from 3 to 10-ton capacities, has been announced by the J. M. Case Trailer Company, of Grand Rapids, Mich.

A feature of the line that is of special interest to contractors and municipal departments is a trailer chassis equipped with gravity steel dump body.

An important innovation is a new jacking device of the double post type, which can be operated by one man from



J. M. CASE STANDARD STAKE BODY SEMI-TRAILER WITH JACKS.

either side of the trailer. When not in use the jack is swung up out of the way, and as it is permanently attached to the trailer it is always ready for service.

Any of the Case semi-trailers can be instantly converted into a four-wheeled trailer by simply adding the Case front running gear. The front running gear unit is built in various sizes to correspond with the various semi-trailer capacities included in the line.

Coming Conventions

WASHINGTON STATE GOOD ROADS ASSOCIATION—Annual convention at Pasco, Wash., Nov. 14-15. Sec'y, Clancey M. Lewis, Seattle, Wash.

SOUTHERN APPALACHIAN GOOD ROADS ASSOCIATION—Annual meeting at Asheville, N. C., Nov. 19-21. President, A. Dennis Williams, Morgantown, W. Va.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS—Annual meeting at Chicago, Dec. 2-6. Acting Sec'y, A. Dennis Williams, Morgantown, W. Va.

HIGHWAY INDUSTRIES ASSOCIATION—Joint meeting in Chicago, Dec. 4 and 5, with American Association of State Highway Officials.

NATIONAL MUNICIPAL LEAGUE—Conference at Rochester, N. Y., Nov. 20-22, to discuss reconstruction problems. Sec'y, Clinton Rogers Woodruff, Philadelphia, Pa.

AMERICAN PUBLIC HEALTH ASSOCIATION—Annual convention at Chicago, Dec. 9-12 (note change in date). Sec'y, A. W. Hedrick, 126 Massachusetts Ave., Boston, Mass.

Trade Note

The Chicago Pneumatic Tool Co. announces that contract has been let and work started on the erection of an up-to-date addition to their Cleveland plant, which is planned to double the present output. It is expected that work will be completed on the building itself about November 1st. The necessary equipment has been ordered and it is believed will be delivered and ready for installation by the time the building is completed, so that the additional production contemplated will be available very soon thereafter.

EDITORIALS

Immediate Resumption of Public Improvements Recommended By War Industries Board

All restrictions on the making of public improvements have been removed with the exception of those implied by the continuance in authority of the Capital Issues Committee which passes upon bond issues. The policy of this committee is sure to be very liberal so, to all intents and purposes, there is nothing of a legal nature remaining to obstruct the normal development of the country.

This change for the better has been rapid beyond the most optimistic hopes. A month ago all sorts of restrictions were in force, not only effectually stopping construction work but consuming enormous amounts of time and energy in the vain effort to get something done. Happily, those days have passed.

The construction industry has suffered more from the war, in the opinion of the President of the Chamber of Commerce of the United States, than any other industry in the country. No one acquainted with the facts will dispute this statement. But if the construction industry fell far and landed heavily it is in for a sensational rebound. It is now apparent to every thinking person that construction must absorb the labor and materials released by the suspension of war industries.

In the midst of the rejoicing at the deliverance from the conditions imposed on non-war construction, it began to appear that some cities that had been restrained from making improvements would persist in the do-nothing policy after the lifting of the restrictions, arguing that present labor and material prices make the construction of public works inadvisable. This attitude is not only fallacious, but decidedly unpatriotic.

Patriotism was the cause of stopping construction, so let patriotism start construction going again. City officials were quick enough to stop work at the suggestion of the government; it is to be hoped they will be equally responsive now that Bernard Baruch, chairman of the War Industries Board, has said:

> With returning peace and until normal conditions prevail great obligations rest not alone with the people, but with national, state and municipal governments to go ahead with improvements, even at sacrifices, in order to make the adjustment as gradual as possible.
>
> With this end in view, it would be of great assistance if public work of all kind that can be done should be undertaken with the least possible delay.

Let us leave it to the Peace Delegates to wind up the war and turn all our thought to the resumption of the normal life of the nation. Peace has its slackers no less than war. A city that does not now push public work is a slacker city; it is failing in the paramount patriotic duty of the hour.

A Promise and Its Fulfillment, and Another Promise

A year ago this month this publication announced a list of special contributors to the editorial columns for the year 1918. Great as was our pleasure in making the announcement, even more satisfaction is felt in calling attention to the fact that the articles promised were, with few exceptions, received and published in the course of the year. The few exceptions are easily explained. The few announced contributors who were unable to submit articles are absolved from all criticism in the matter because, without exception, they were engaged in work directly connected with the winning of the war. Only an unfriendly critic would argue that we have not made good our promise to publish articles by many of the leading authorities in this field.

In this issue we announce the list of special contributors already secured for the year 1919. This list is of the same high quality as that anounced a year ago, and is much more extensive. While it would be poor taste to single out various parts of the list for special editorial comment, simple justice to ourselves compels the calling of attention to the contributors of articles on Hard Surface Roads and Pavements. It will not escape the attention of the discerning that this is a truly remarkable list, from whatever angle it is viewed. It contains seventy-five percent of the chief engineers of the several state highway commissions and also a large number of other men closely and influentially associated with the design, construction and maintenance of hard surface roads and pavements. For every other branch of municipal and county engineering work the list of contributors is also highly satisfactory to the publishers, and we believe that all readers will feel that their interests have been fully considered and amply safeguarded.

Not all the articles published in 1918 were announced in December, 1917, and all the articles to be published in 1919 cannot be announced now. It will be obvious to all that no publisher can tell months in advance all that his magazine will contain. But we are announcing, at this time, enough good articles to guarantee the high quality of this publication for the next twelve months. Whatever other magazines may or may not be read by workers in the municipal and county engineering field, the publication of this announcement is a sure guarantee that those who will read will find in the editorial columns of Municipal and County Engineering a great deal of matter, of the highest quality, which because of its origin in this publication will not be found elsewhere.

It is Perfectly Easy to Bring on a Panic

That the only thing needed to insure a year of great prosperity is a determination on the part of everyone to go ahead with absolute confidence in the future, is the view Thomas A. Edison recently expressed to his business associates.

"There are those who fear a business depression,"

said Mr. Edison. "The surest way to bring on a depression of business is to nurture fears and act hesitatingly. The business men of this country must see to it that employment is provided for our war workers and returned soldiers."

We should have learned something from tariff revision. If the revision is downward it is sure to produce a depression for such revision is contrary to the wishes of a majority of the business community. Resenting the lowering of the tariff, business sulks in its tent until the hard times so brought on cause voters and legislators to repent their presumptuous course and to revise the tariff schedules upward. Then industry hums again, everybody goes back to work and for a time all is serene. It is said that protection has again demonstrated its soundness. Of course it has done nothing of the kind, although it may be, and probably is, perfectly sound. What has been demonstrated is that by tightening up on money, by discouraging all new enterprises, hard times are inevitably brought on. Tariff tinkering always produces this effect. Anything else that shakes the confidence of the business interests in future values will produce a like effect.

Edison is right. If work is not provided for laboring men to do we shall have a depression. This is case one in the primer of economics. Its truth has so often been demonstrated, and is so obvious, that it is to be hoped the country will not want to demonstrate it again.

Getting Accustomed to Large Sums of Money

One of the major benefits of the war is the discovery of the wealth of this country. A million dollars is still a large sum when in the possession of an individual, but it is not large for a populous community and is just small change to the federal government. We have learned to think in big figures. When McAdoo set the goal at two billion dollars in the First Liberty Loan his advisers insisted he was making a mistake, and urged him to ask for only a half billion. How the loan was easily oversubscribed is now a matter of history. When he asked for six billions on the Fourth Loan there was some skepticism about the response, but the response left nothing to be desired.

It is not too much to expect that the federal government, state governments and the large cities having learned what they can do in raising money for war purposes will apply this knowledge to the financial problems of peace times. There was a time when this country was proud of building the Panama Canal at a cost of $300,000,000. That was a lot of money in the day of small things. The Chicago district raised almost that much money on the Fourth Liberty Loan. A few millions more or less will hereafter hardly stand between this city and anything it wants. Other communities have also learned their financial strength.

Next time the federal government sets out to aid in the construction of roads it will not feel it has done enough by appropriating a few millions of dollars. The public would approve the expenditure of a billion dollars for that purpose right now. The plain man will argue that if we can raise billions for war purposes we can raise a billion now and then for some constructive purpose such as the building of dependable highways.

Incidentally, the citizen has learned to buy bonds. Hereafter it should be easy to dispose of improvement bond issues to local banks, who in turn can sell the bonds to their customers, over the counter, on the installment plan.

Dramatic Popular Endorsement of Good Roads in Illinois and Pennsylvania

That the people of the country demand good roads was never better illustrated than by the votes cast by the people of Illinois and Pennsylvania at the November elections. The great majorities favoring road improvements would be gratifying at any time, but were especially encouraging and significant, coming as they did before the signing of the armistice. In Illinois $60,000,000 and in Pennsylvania $50,000,000 in road bonds were voted.

In Illinois surveys are well under way for approximately 300 miles of roads located on the $60,000,000 bond issue system, but which are to be improved mainly from the combined federal, state and county funds. It will not take long to complete an additional 300 miles so as to be ready to let contracts early in 1919. The present outlook is that contracts for from 600 to 800 miles of hard surface roads will be awarded in Illinois the coming year.

In Pennsylvania the people, by an overwhelming majority, approved an amendment to the constitution authorizing the state to issue bonds to the amount of $50,000,000 for roads. It is now up to the State Legislature, which meets in January, to pass the necessary legislation and to make provisions for the use of the money to be derived from the sale of the bonds.

The Pennsylvania State Highway Department has plans worked out for the improvement of important roads in each county which will eventually work into a definite state system. No doubt the money will be allotted on a mileage basis so that each county will receive its proper share.

The example of these two leading states is destined to be followed, we are confident, by many other states. It is in this connection that the popular endorsement of good roads in these two states is most gratifying. While relatively spectacular the sums involved would be misleading if accepted as a measure of what is to be expended on roads. These figures will be dwarfed by the aggregate sum to be expended on road improvements in the years immediately before us.

Military Titles in Peace Times

A considerable number of engineers and contractors have received officers commissions during the war. A disquieting thought occurs. Must we address these gentlemen as Colonel, Major or Captain henceforth? Undoubtedly it is the custom to carry military titles back into civil life. We have no disposition to quarrel with this custom, but times change and it may be that these officers will prefer to revert to just plain "Mr." when they change back to civilian clothes. Obviously, whether the military titles are retained or not will depend on the wishes of the individuals most concerned. We are perfectly willing to be governed by whatever the amenities of the situation may require. But it is respectfully urged that charity be exercised if we are to employ the military titles. We want it perfectly well understood that no offense is intended if we address a Colonel as "Corporal," or vice versa.

Construction Methods Employed in Building Lincoln Highway Cut-off Across the Desert at Gold Hill, Utah.

By R. E. Dillree, Construction Engineer, Utah State Road Commission, Gold Hill, Utah

One of the most important projects for betterment of the Lincoln Highway is now under way in Utah where a cutoff is being constructed across an arm of the desert, to shorten the route about 50 miles and eliminate some of the worst pieces of road to be found anywhere. The cutoff proper will be about 17 miles long. The work is being done by the state road commission of Utah with funds supplied by the Lincoln Highway Association. About 10 miles of the sub-grade has been completed, and the cutoff will probably be passable for tourists by the end of the year, if not entirely finished. The estimated cost of the project is $100,000, of which $75,000 was contributed by the Goodyear Tire & Rubber Company, while F. A. Seiberling, president of that corporation, and, also, of the Lincoln Highway Association, personally contributed $25,000.

Geological Conditions

In many parts of the western states are found numerous dessicated lake beds dating from prehistoric times, of which the largest is that of former Lake Bonneville, which surrounds Great Salt Lake on the north, west and south and is known as the Great Salt Lake desert, embracing an area of thousands of square miles. The surface of the desert is practically level, having only slight inequalities, drainage being north toward the middle of the desert. Being of sedimentary origin, the surface material of the desert is principally silt carrying high percentages of mineral salts. In places where drainage is fairly good the surface dries and hardens until it forms a crust as smooth and even as an asphalt pavement; but where drainage conditions are not good, or during seasons of abnormal rainfall, where there is much travel the material cuts into deep ruts and "niggerheads," making maintenance of passable roads almost impossible. Such conditions prevail along the Lincoln Highway near the Fish Springs mountains, where travel is extremely difficult because of the numerous and deep mud-holes. To eliminate this serious drawback to practical use of the highway as a transcontinental business and pleasure thoroughfare, the directors of the association some years ago conceived the idea of changing the route and building a cutoff across the desert arm about 20 miles to the north of Fish Springs mountains.

Job Too Hazardous for Contractors

Although funds for the project were available for several years past, no private contractor could be induced to undertake the work, so last spring the association directors entered into a contract with the state road commission of Utah to carry out the plans, using the commission's road-making forces and equipment, the sum of $100,000 being deposited to the credit of the commission in Salt Lake banks.

The project involves changing the route of the highway west from Orr's ranch to the eastern side of the Deep Creek mountains, passing around the northern end of Granite mountain. Between Orr's and Granite, while it is a barren country, no unusual features are found to obstruct construction of a good road, but west of Granite mountain the new route of the highway crosses the arm of the real desert. This has been crossed in times past by occasional freighters and travelers in vehicles of various kinds, but always at great hazard. While the surface stratum dries in places sufficiently to sustain heavy loads without cutting deep, the thickness is not great. In many places are found soft spots that appear to have no bottom, while the whole flat becomes impassable when wet. To change the route of the highway as planned, it was necessary, therefore, to construct a roadway with a grade above the level of the desert. As it was impossible to get road-making equipment to the west side of Granite mountain, construction forces and equipment of the state road commission were assembled in July at Gold Hill, Utah, from which place it was necessary to build a new road to the west "shoreline" of the desert arm and out to Black Point, a distance of 12 miles, where a construction camp was established.

Black Point is a low projection of black limestone 4½ miles out from the western edge of the desert, being connected with the lower slope of the Deep Creek mountains by a low ridge averaging a few feet higher than the flats, while the Point rises to a height of 30 or 40 ft. above the desert level. Actual grading operations began August 1, and have since

CONSTRUCTION EQUIPMENT USED ON LINCOLN HIGHWAY CUT-OFF AT GOLD HILL, UTAH.

Top Row:—Plowing for Borrow Pits. Tenth Mile—Elevating Grader Pulled by 75-H-P. Caterpillar Tractor with 90-H-P. Cat. in Lead—Close View Casting End of Grader. Borrow Row:—Caterpillar and Grader in Operation—Showing Mud Paddles Attached to Track of Caterpillar to Prevent Sticking in Mud—Another View of Paddles. The Autor, Mr. Dillree, at Side of Caterpillar.

been carried on continuously, working two or three 8-hour shifts a day. By the first of November the sub-grade was completed into the 10th mile, and a part of the completed portion surfaced with gravel.

Design of the Roadway

The specifications call for a roadway of three-course construction, divided for reference purposes into sub-grade, to be composed of desert material, with crown and wearing courses of gravel. The minimum depth of sub-grade allowed is 18 ins. above the highest inequalities of the natural surface and a greater depth over low places to maintain a level roadway, with a top width of 18 ft., and the side-slopes 1½ ft. horizontal to 1 ft. vertical. The crown course of gravel is to be 5 ins. deep, of gravel or rock 3 ins. and less in size, while the maximum size of material for the wearing course is 1½ ins., not more than 12 per cent., by weight, to pass a 10-mesh sieve. Each course to be smoothed and well-rolled before the next course is applied. The original estimates called for moving 90,000 cu. yds. of material in making the sub-grade, and 30,000 cu. yds. of gravel for both the other courses. In building the sub-grade for the first eight miles 72,000 cu. yds. of material were actually handled, the top of the sub-grade being made 20 ft. wide. Culverts constructed of lumber are required to be placed wherever there appears to be need of them.

Construction Equipment and Methods Employed

Three C. L. Best caterpillars, one of 90 and two of 75 h. p., with one 65 h. p. Holt caterpillar, supply power for operations, the sub-grade material being handled by two New Era elevating graders, and the surfacing gravel by one Jeffery loader. Other equipment consists of two Russell blade machines, a four-gang plow, 16 Troy trailers of 5 tons capacity, one 5-ton White truck with 24-in. iron rear wheels for rolling, and a 1½-ton White truck. A complete machine and blacksmith shop is established at Black Point.

The caterpillars are used to haul the elevating graders, but before being put into service had to be equipped with tumbling-shaft connection from the master gear to elevator on grader, to operate it, this connection being installed at the Black Point shops. Experience has demonstrated that it would be impossible to haul the graders with horses, or to make use of horses on any part of the work. If teams could be used a force of 90 men would be needed, whereas, the same amount of work they could accomplish is being done with a force of 28 men.

The dirt is cast directly into the fill from the elevators of the grading machines, and a gradual slope from the toe of the fill to the outside of the barrow pits is maintained to gain the greatest drainage advantage. As natural drainage of the desert to the north is slow, and as large bodies of water collect after rainfall on either side of the fill, numerous culverts are placed to equalize the flow of water, which is controlled largely by the direction of the wind. A blanket of gravel is placed along the slopes of the fill to protect it from wave action induced by winds. When parts of the fill are sufficiently high they are rolled and the lumps are broken by caterpillars traveling back and forth, after which the fill is worked to an even surface with blade machines, final rolling being done with the wide-wheeled White truck to prepare it for receiving the gravel. The fill is made slightly lower along the middle to permit thicker courses of gravel where the greatest wear will come. A natural bed of gravel at Black Point will supply material to hallast and finish the roadway, and will be distributed with trains of Troy trailers hauled by caterpillars.

During the month of August 32,000 cu. yds. of material were handled in making four miles of sub-grade 20 ft. wide, using one elevating grader and working two 8-hour shifts with two crews of three men each to take advantage of the long daylight hours.

In September another four miles of fill were completed by operating two elevating graders, working two 8-hour shifts with four crews of three men each most of the time, although the work was kept going 24 hours a day when the fifth mile was being finished. A total of 40,000 cu. yds. were handled.

Overcoming Difficulties Encountered

For the first mile out from Black Point the surface material proved to be sandy, and to a depth of 3 ft. was readily handled. Below 3 ft. mire or slimy silt was encountered. Along the second and third miles the material was found to be salty silt pitted with white clay deposits. The clay deposits were of varying area and seriously interfered with operations because they were soft, and the machines frequently got mired too deep to be pulled out. It was necessary to jack them up to move them, but before that could be done it was necessary to construct a foundation for the jack. Hay and timbers were used for the purpose, and then the places were corduroyed with timbers so they would cause no further trouble when the machines passed again. Along the fourth mile the desert material proved to be a rich soil pregnant with vegetable matter, providing a firm, solid footing, and the mile was completed without unusual effort.

The fifth mile called for the utmost exertion of all man and machine energy on the job, and it was not completed until after the sixth, seventh and eighth miles because of the character of the material and the amount of water with which it was saturated.

The material was a white clay spotted with deposits of salt slime, and so wet that the caterpillars could not be guided in the proper direction, and they had no traction. When a grader was attached the caterpillars would simply dig holes from which it was difficult to extricate them, even the fly-wheels getting down in the mud. The weather being favorable, plowing was resorted to in hopes the hot winds would dry out some of the moisture, and operations were then transferred to the three miles beyond. After building the sub-grade for the sixth, seventh and eighth miles conditions along the fifth were slightly improved, and with great effort the fifth was completed.

Using Hay to Keep Heavy Equipment from Bogging Down

In one place it was necessary to use four tons of hay before work could proceed, and even then three caterpillars, with a combined horsepower of 230, were required to pull one elevating grader. The grader was coupled to one caterpillar that traveled in the borrow pit, while the two other caterpillars were connected ahead and at the sides with chains, one traveling the partly-completed fill, and the other on the desert outside the borrow pit. This mile crosses the Redding spring wash, the underground flow from which causes saturation of the desert material. Breakdowns were frequent, and it was only by the exercise of ingenuity and all available resources that the mile was finally brought to grade.

For the sixth, seventh and eighth miles the material was very similar to that along the fourth, except that what appeared to be former shallow water courses were found filled with shale-like deposits 2 to 3 ft. thick and 10 to 50 ft. wide, at right angles to the fill. These shaly deposits covered salt slime deposits of unknown depth and occasioned a great deal of trouble by causing the plow of the grader to rise, resulting in uneven casting of material into the fill. And when once a machine broke through them, hours of hard work were sometimes required to release the machine from the slime.

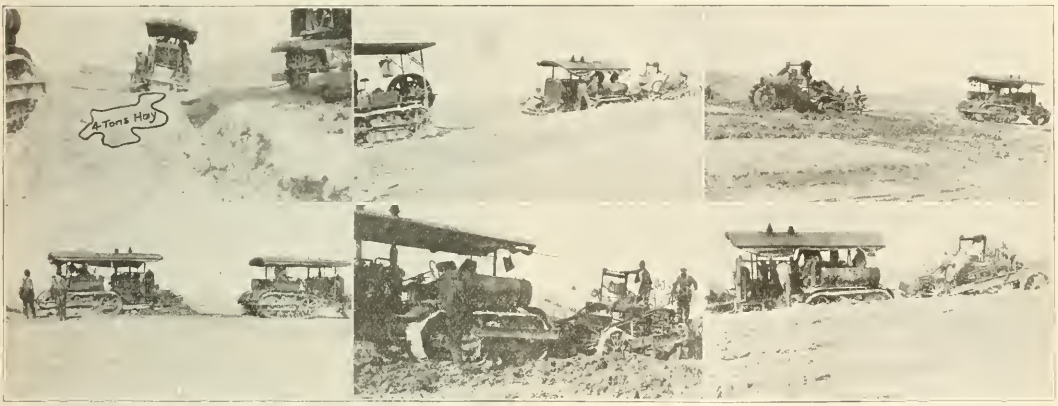
Conditions Very Difficult

Work on the ninth and the first half of the tenth miles disclosed similar conditions, with the addition of soft spots in which caterpillars and graders frequently mired. An inspection of the desert for 6,000 ft. beyond the middle of the tenth mile showed the material to be very salty white clay with numerous salt slime deposits. This part of the cutoff course crosses the Fish Springs wash where I anticipate a

hard struggle, as it is the critical stage of the work. But I have had more than 20 years' experience in charge of dirt-moving projects—in hard and soft ground, and through tule marshes and swamps—and will overcome all obstacles here by "staying in the harness with my head cut in."

All water for camp and radiator use is hauled from Round Spring, five miles back and south from Black Point, and all other supplies are brought by truck from Gold Hill. To avoid loss of time, after the Fish Springs wash is crossed the lodging tents for the men will be put on runners and hauled by caterpillars out to the end of the grade, where boarding house and machine shops will be set up and a new camp established, as water can then be obtained from a spring on Granite mountain.

Heavy rains have increased disadvantages at times, while high winds are frequent during which time the air is filled with flying particles of pure salt which promise to fill the borrow pits gradually in places. Even under ordinary conditions much of the desert surface is slippery, and moisture rises to the surface at night and on cloudy days, while 2 ins. under the surface the material generally has the consistency of putty.



DIFFICULT CONDITIONS ENCOUNTERED IN BUILDING LINCOLN HIGHWAY CUT-OFF AT GOLD HILL, UTAH.

Top Row:—Head-on View, Fifth Mile, Grader Being Pulled by One Caterpillar. Assisted by Two Others Ahead and at Sides of Borrow Pit—Shows Where 4 Tons of Hay Were Used to Fill Hole in Pit—Caterpillar and Grader in Soft Mud of Borrow Pit, Being Assisted by Caterpillar on Fill—Necessary to Feed Distillate by Hand to Keep Moving—Grader Stuck in Hole Being Pulled Out by 75-H.P. Caterpillar. Bottom Row:—75-H.P. Cat. Being Pulled Out of Soft Place by 90-H.P. Cat.—View Off Side Grader and Caterpillar—Down in the Mud, Fifth Mile.

Moving Pictures Taken

Completion of this project will be marked by suitable formal ceremonies of dedication in which the governors of Utah and Nevada will participate. Progress has several times been inspected by H. C. Ostermann, field secretary for the Lincoln Highway Association, who is enthusiastic regarding the project, and was the first to try its speed possibilities. In a twin-six Packard he attained a speed of 82 miles an hour for two miles, shortly after first four miles of sub-grade had been finished, and before any gravel was applied. The first moving pictures of the cutoff in use were staged when two immense trucks carrying Goodyear tires to San Francisco were detoured for the purpose from the present route of the highway some weeks ago. Moving pictures of construction operations were taken at the same time.

The Cutoff a Monument to Enterprise and Generosity

The cutoff will be a lasting monument to the enterprise of the Lincoln Highway Association, and to the generosity of Mr. Seiberling, and will prove a most valuable link in what will probably become one of the main transcontinental highways under government control, and it may quite properly be suggested to other wealthy corporations and individuals that the enterprise and generosity displayed should be more generally emulated.

Trend of Wages Paid By American Water Works

By Leonard Metcalf, of Metcalf & Eddy, Consulting Engineers, Boston, Mass.

Some interesting studies of the increase in cost of labor to American Water Works, were recently reported in the Journal of the American Water Works Association, September, 1918.

Conditions in 50 Plants

The records submitted by 50 typical important works, both large and small, municipally and corporately owned, scattered all over the country, showed that the advance in cost of labor did not begin generally until late in 1916 and did not become serious until the latter part of the following year. The average advance over the pre-war conditions, was 13% in the year 1916, and 27% in the year 1917, and it was reported that the advance was still under way. Equally serious was the reported decrease in efficiency of labor, which the concensus seemed to indicate was between 25 and 35 per cent., indicating that the actual increase in cost of labor, up to the end of the year 1917, was approximately 50% over pre-war prices.

The cost of the important materials of construction—such as pipe, fittings, valves and machinery—and of the important materials of operation—fuel and chemicals—had more than doubled. It was clear, further, that serious and conscientious effort had been made by water works operators the country over, to reduce construction and operating forces and expenses, to a minimum, and that these reductions had already gone beyond desirable limits, in many cases even to reducing the working efficiency of the properties, though it was recognized that in other cases still greater economies in the better consumption of fuel and reduction of waste were possible. Meanwhile, the net revenues of these works had very generally suffered a marked decline, that of the plants having to pump their supplies being more serious than of those having gravity sources. The menace of the situation to the adequacy and safety of the water supplies, was recognized, as was the danger that the failure to advance the wage scale sufficiently to hold

the old, skilled and better informed employes of water works might result in still more serious consequences through loss of the men familiar with these properties and their proper operation.

Studies Made in the Vicinity of Boston

Some further studies of the conditions prevailing about Boston were made in the month of September, 1918, by the writer, as a basis for determining his action upon a petition for increase in wages paid by the water department of his home town in Massachusetts. These showed that the practice in various water departments, with regard to the length of the working week, varies considerably. In many the 44-hour week is observed throughout the year; in some during a period of from 3 to 5 months, with a 48-hour week for the remainder of the year; and in a few cases 48 hours per week throughout the year. In many cases two weeks' vacation, without loss of pay, is allowed to permanent men; in a few cases, none. Legal holidays are allowed to permanent men, with pay, in many cases; in others but three to four holidays per year; and in some cases no pay is given for holidays unless labor be actively employed upon them.

In computing the wage rate per hour, of 24 different works in the vicinity of Boston, operating under the conditions above referred to, allowance was made for the length of the working week, but no account could be taken of the holidays or vacations allowed with pay, on account of the lack of specific data. It was found that the ruling rate of wage of common labor varied generally from $3 to $3.25 per day, and averaged approximately 41c per hour. This is comparable with pre-war conditions, varying in these Massachusetts cities from 28c to 35c per hour, involving an increase from 17% to 45%. It is further significant to note that contractors were paying common labor in this district, during the same period, approximately 50c per hour, 22% in excess of the wages paid to water works employes, under conditions of practically constant employment, and 78% in advance of the rate of wage, upon contract work, ruling before the war.

Some advance has taken place since these figures were gathered.

Conditions Confronting Water Works

Elsewhere over the country marked advances in wages over those of 1917, are reported, and increasing difficulty has been experienced in the maintenance of requisite operating forces.

How many superintendents of water works are now bearing cheerfully an unusual burden of long hours of overtime work, in the effort to keep their plants running, and are thus creditably contributing their bit toward the winning of the war?

With the growing probability of the conclusion of peace within the year 1919—for the negotiations following the signing of the armistices are certain to involve substantial periods of time—it is interesting to speculate upon the conditions which American water works are likely to face thereafter.

It seems highly probably that peace will be followed by a very difficult period of readjustment of government activities, industry and labor. Two years may be required to return to this country the American troops. The shortage of ships and home conditions will prevent any immediate and rapid influx of foreign labor to the United States. The reconstruction program abroad will involve a heavy drain upon materials, natural resources and labor in this country.

The concessions made to labor during the war—decreasing the working day to eight hours, the payment of an increased wage for overtime, the increase of two day-shifts to three, the giving of holidays and vacations under pay, and the reduction in the normal weekly hours of work, will certainly continue in most cases, unless unexpected panic should follow the war.

Conditions Will Increase Use of Labor Saving Devices

Therefore, while the conditions of depleted labor supply will be bettered, they will be far from normal and will continue to be burdensome for several years at least; will tend to enforce the increasing judicious use of labor-saving devices; and will seriously limit the activities of our water works.

Long postponed construction will be resumed slowly at first, by reason of maintenance of the high cost of materials and labor involved by the reconstruction and rehabilitation of destroyed property, as well as in growing needs, but will gradually increase through the coming decade.

Many injured soldiers capable of limited service, will doubtless be drawn into the work, but sentiment and physical disability requiring a greater number of injured than of healthy normal men to do a given task, will largely offset any saving of cost in their employment. Later, as surplus of labor develops and costs of materials diminish, reduction in wages from present levels must follow. Some reduction—perhaps 10 to 20 per cent., may be experienced within a year after the signing of peace terms, and be followed by further decline; but the old normal pre-war level will never return, save perhaps momentarily in future panics. The costs of the war are sure to be absorbed in large measure by inflation, that is, by permanent decrease in the purchasing power of money.

Inefficiency, Hunger and Bolshevism

The restoration of old standards of efficiency of labor, and the banishment of the present spirit of discontent, are the most serious problems of the day. Bolshevism has run riot in Russia, fostered by Germany, and now Austria and even Germany face similar tendencies which they may not be able to control. The return to their homes of the Austrian troops and of the Germans, to find shortage of food and lack of opportunity to take up at once their old tasks, may well fan the embers of Bolshevism into flames of anarchy and destruction. Experience has shown that the action of a man with starving family, as those of a Chinese coolie with empty belly, may not be forecast; therefore the immediate and stupendous task of the United States and her allies is to assist in distributing the food necessary to the defeated, as well as to the conquering nations. This tremendous task will tend to continue the labor shortage in this country. Worse yet, the further spread of pernicious and destructive socialistic and anarchistic propaganda may become a very serious problem to the United States as well as to other powers.

Will the United States escape the foreign experience, or are our past I. W. W. disorders significant symptoms of further more serious troubles and destruction of property? It seems probable that we shall escape the Russian holocaust. The return of our fighting men, chastened by the sight of the fruitlessness, impracticability and destructiveness of such ideas, should act as a staying influence to the continued rapid growth in this country of socialism and the willingness to experiment with new forms of government. Of late there has been too great a readiness to throw to the wind years of world experience, to adopt new forms of government and to urge the idea of governmental, rather than personal, initiative, in the effort to offset the effect of lack of hearty co-operation. Never has there been a time when good balance and calm judgment in dealing fairly with labor, in the settlement of these fundamentally important problems, were more needed.

It is clear that the outlook for reduced cost in the operation of American water works is not encouraging, and that the trend in cost of materials and labor, during the next two to five years, must be along the line of continued high prices. We must adjust ourselves to the fact that of the advance in present prices over pre-war prices, from 20% to 30% or more is permanent, and that the attitude of labor requires in its treatment firmness, together with fairness and real consideration, if efficiency is to be realized in the future construction and operation of American water works.

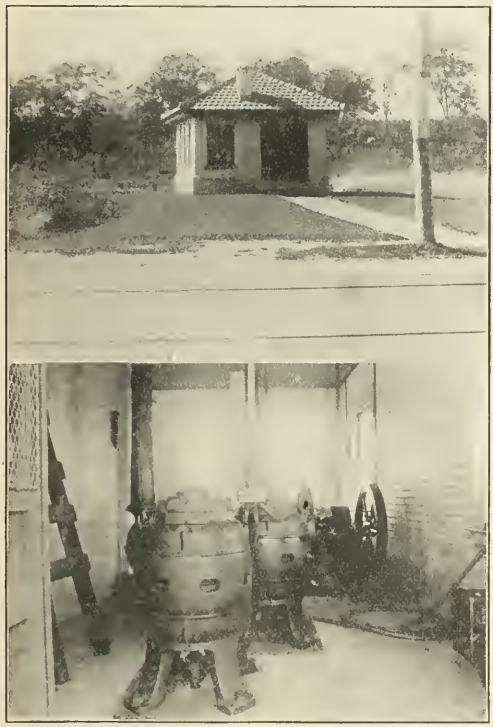
Design and Operation of Automatic Sewage Pumping Station at West Haven, Conn.

By Clyde Potts, Civil and Sanitary Engineer, 30 Church St., New York, N. Y.

In designing the sewerage system for West Haven, Connecticut, which is a suburb of New Haven, and situated just across the West river from the city, one of the chief problems was to drain the sewage to a common point for treatment. West Haven is situated on Long Island Sound and the major portion of the town is less than 20 ft. above mean tide. The town had been unsewered prior to the time of the installation of the present sewerage system, although practically all of the houses in the town were equipped with modern plumbing conveniences.

Sewage Treatment Works

The Savin Rock amusement center is located within the West Haven sewerage district, and on account of the bathing, clamming, etc., it was necessary to provide sewage disposal works and treat all of the sewage from the town before the



EXTERIOR AND INTERIOR VIEWS OF THE BRADLEY POINT SEWAGE PUMPING STATION, WEST HAVEN, CONN.

some was discharged into Long Island Sound or the New Haven harbor. The type of sewage disposal works chosen was Imhoff tanks followed by disinfection with chlorine gas. This plant was located in the eastern part of the town, discharging into Long Island Sound, through a wood-stave pipe outlet. The water level or flow line in the tanks was taken as plus four, which is about 1 ft. higher than high tide. This elevation permitted practically all of the Savin Rock District to drain into the plant by gravity.

Automatic Sewage Pumping

There was, however, a small section in the western part of the town situated about 1½ miles from the plant in which the elevations were too low to permit the sewage to reach the plant by gravity; in all about 2 miles of street laterals, including the public comfort stations of Savin Rock and some of the hotels and amusement centers.

To avoid establishing a separate disposal plant in the western part of the town it was decided to install a small automatic pumping station at Bradley Point for the purpose of raising the sewage from this Bradley Point District into the main district whence it could flow through the main trunk line to the disposal plant, about 1½ miles to the eastward. The main trunk line for the Savin Rock District begins at the disposal plant and is laid westerly along Beach street and collects the sewage from different subtrunks. This trunk sewer extends to the Bradley Point District, the last 2,500 ft. of it being 15 ins. in diameter. The sewage from the automatic pumping station is discharged directly into the westerly end of the 15 in. trunk sewer. By reason of the flushing effect of the discharge from the pumping station this trunk sewer was laid with a grade of but three hundredths of a foot per 100 ft. This flat grade reduces the velocity in the trunk sewer to about 1 ft. per second. In view of the method of operating the pumping station this grade has proven entirely satisfactory.

The sewerage system in the Savin Rock District was put in service in May of 1915, and during the first few months of its operation the sewage was pumped with the auxiliary gasoline engine outfit. This was done in order to permit the Savin Rock amusement pavilions to use the sewers during the summer season, as upwards of thirty of forty thousand people congregate in the amusement pavilions during this time.

The Automatic Control

The sewage pumping station is automatically controlled. The superintendent of sewers visits it but once a day for inspection purposes. Essentially the pumping station consists of two 5 in. vertical centrifugal pumps, direct connected to two 5 h. p. vertical motors. The pumps are situated in a dry pit adjoining the sewage well. The sewage from the sewers enters a sewage well through bar screens. As the sewage rises in the sewage well it floods the centrifugal pumps through the suction, and when it reaches a predetermined level it raises a float which throws the current into the motors. An automatic switch is provided so that the motor is not thrown directly across the line until three intermediate speeds have been thrown in.

Sewage Screens

No attempt is made to screen any appreciable amount of solids in the sewage. The screens are rather a precautionary measure to prevent sticks and rags from clogging the pumps. A 5 in. horizontal centrifugal pump driven by a gasoline engine is provided as an auxiliary should anything happen to the electric current. Both electric pumps are controlled by floats in the sewage well. In the event that one pump is not sufficient to keep the sewage pumped down and it continues to rise in the sewage well the float operating the second pump will rise and start the second pump. It has happened on some of the busy days at the Savin Rock for short periods that both pumps have been called into service. Under ordinary average conditions, if average conditions are possible, one pump operates for about 10 minutes, during which time it empties the sewage well and then will automatically cut out and rest for 30 minutes while the sewage well is filling up, when it cuts in again, and so on, making about 40 minutes per cycle, or 36 cycles per day. This amounts to virtually 6 hours of continuous pumping. There are times, however, during the amusement season, when these figures are exceeded. The rate of inflow into the pumping station under ordinary conditions is about 130 gals. per minute, or a trifle more than 185,000 gals. per day.

Cost of Electric Current

The cost for electric current for the last 16 months has been as follows:

April 28, 1917, to May 25, 1917	$31.75
May 25, 1917, to June 26, 1917	30.80
June 26, 1917, to July 27, 1917	29.51
July 27, 1917, to Nov. 24, 1917 (3 months)	92.01
Nov. 24, 1917, to Dec. 27, 1917	25.01
Dec. 27, 1917, to Jan. 23, 1917	30.00
Jan. 23, 1917, to Feb. 23, 1917	28.40
Feb. 23, 1917, to Mar. 23, 1917	37.60
Mar. 23, 1917, to Apr. 23, 1917	46.40
April 23, 1917, to May 23, 1917	56.40
May 23, 1917, to June 22, 1917	52.40
June 22, 1917, to July 22, 1917	69.50
July 22, 1917, to Aug. 22, 1917	48.40
Aug. 22, 1917, to Sept. 23, 1917	38.00

For specific cases I have computed it to be at the rate of about $6 per 1,000,000 gals. of sewage pumped. Aside from the electric current cost there is very little expense attached to the operation of the plant. The superintendent of sewers inspects the plant daily, at which time he fills the grease cups, oil cups, etc.

An alarm clock at the Town Hall is operated by a float at the pumping station in the event that any mishap should occur and the pumps not operate as they should.

The contract price of the pumping station was $6,000, and it was built during the fall of 1914 and the spring of 1915.

The Aims of Engineers Engaged in Road Work

By Rodman Wilcy, Commissioner of Public Roads of Kentucky, Frankfort, Ky.

It is pertinent at this time that you should better understand the aims of the engineers engaged in road work. Some of you might think that on occasions they are arbitrary, dictatorial and altogether undesirable persons, who try to say to the various fiscal courts what they should and should not do, but such is not the case. They are laboring for your interests; they are anxious to see every administration a success regardless of what political power may be in control; they are your servants, not your masters, and they realize that in its final analysis the people are their clients, said Mr. Wiley in addressing the Kentucky Highway Engineers' Association on November 12, 1918.

Financing

In the financial end of road work engineers are oftentimes called upon to make an examination of the road needs of a community, the possible resources, and to report to the constituted authorities the amount of money needed and the best method of securing it; at other times they advise with the proper authorities to see if their program is sound from a financial standpoint, just the same as engineers are called upon to report to bankers and brokers on the soundness of investments in other lines of work. Today very few investments of any size are made unless the proposition has the approval of some well known engineer in whom the investors have implicit confidence.

Location

Everyone has seen on numerous occasions the mistakes that have been made by viewers in locating roads. It must be remembered that wherever a road is built, schoolhouses, residences, churches and business houses will follow the development. In case the location is bad, it is most difficult and oftentimes impossible to provide any remedy, because if the location is changed all the improvements are lost, consequently the taxpayers are compelled from year to year to pay a heavy cost for maintaining an improperly located road. On the other hand, very few have seen a road located by good engineers that ever needed to be changed. France, Belgium, England and Italy realized centuries ago that whenever any road improvement was started it should be in charge of the most competent engineers in the nation, consequently the roads in those countries have been located with such foresight, such knowledge of the development of the country that it is almost impossible even at this time with all our advanced ideas and new methods of travel to make any desirable changes. Right in our own state when we speak today of the old L. & N. pike there is foremost in every man's mind the thought that the road is located properly and any suggested changes are viewed with suspicion. It has stood the test of public criticism as well as the elements of destruction and the expense for maintenance has at all times been a minimum.

The great trouble has been principally the fault of the taxpayers. They have not called for a business-like administration of the road affairs of their counties and consequently they have not received it.

A road is simply one of the systems of transportation and its location requires as much if not more skill on the part of an engineer as the location of a railroad, because a railroad company usually has ruling grades, ruling degrees of curvature and no departure is allowed from those standards, whereas when locating a road an engineer must have vision. In his mind's eye he must see the country as it will grow and as it will be years after the road is built. Consideration must be given to the finances of the county which is usually not the case in railroad work. A railroad company might expend thousands of dollars to reduce a grade one-half per cent., to reduce the degree of a curve one or two points, but in road work an engineer adopts such grades as will insure the economical construction of the highway, provided, of course, that traffic will not be impeded. Highway location calls for rare judgment on the part of an engineer.

Grading

The grading of a road requires the same amount of skill and experience on the part of the man doing the work as does the grading of any railroad or interurban line. The same kind of machinery, the same instruments are used for both classes of work. A railroad company never considers, for one moment, starting any construction work without having experienced engineers on the ground at all times to see that it is properly done; a contractor doing the work knows from bitter experience that he cannot hope to make money unless he has an experienced man in charge, and I cannot understand how men entrusted to build roads can figure that they can depart from the usual custom or that they can break all precedents and do something that railroad companies and contractors have found to be impossible from an economical standpoint and impracticable from all other angles.

Surfacing

When it comes to surfacing any road, the man in charge should have a thorough knowledge of the behavior of all local materials under different kinds of traffic and different climatic conditions, as well as to understand the method of doing the work. Experience has shown that attention to minute details is necessary if any type of road is properly built. All of you have seen roads built of stone and you know that one man can take a certain amount of stone and build a good road and another man will take the same class of stone and the same amount of stone and build an inferior road. That shows for itself that there is something in a man knowing how.

However, the most important thing about the surfacing of any road is knowing the type to select. A great many men have had sufficient experience to know how to build a gravel road, a macadam road or most any type of road that might be selected but the real engineering comes when we are try-

ing to decide the proper type to build in certain localities. To make a decision intelligently consideration must be given to the finances of the district, availability of materials, local materials, the kind and volume of traffic passing over the road, possible increase in traffic due to the improvement and the approximate cost of maintaining any type that is decided upon.

Hundreds of millions of dollars have been wasted in this country by building the wrong type of road. In this state in the central section, we find almost invariably macadam roads, in Western Kentucky gravel roads and in most instances those types have been built without any consideration whatever being given to the traffic that has or will pass over the road during its life. To my mind, the selection of the proper type of road requires the highest type of engineering ability and before building any road it would be economical and certainly good common sense to get the advice of the foremost engineers in the country as to the most economical type.

Culverts and Bridges

On many of the roads in this state even now we find that it is impossible to transport the ordinary road machinery, because the drainage structures will not carry the loads. Sometimes you see fairly good roads on which there has been installed drainage structures totally unsuited to the traffic. We also find that structures of the wrong size have been built; it is not uncommon to see a 100 ft. span trestle where perhaps a 4x4-ft. culvert would suffice. Oftentimes we see a culvert pipe installed which is totally incapable of carrying the water and even the determination of the proper size of any drainage structure is a high class engineering problem. Everyone should know by this time that the design of culverts and bridges is a branch of engineering that requires years of training and experience.

No railroad company would consider for a moment letting one of their section foremen build a bridge or culvert according to his own ideas; on the contrary, every structure is carefully designed, carefully checked several times before it is ever allowed to be installed. The great trouble with highway work has been that most everyone thinks they understand how to design and build drainage structures and we find today our highways adorned with structures which have little to commend them except the enormous prices paid by an unknowing public.

Maintenance

After a road is built it must be maintained and everyone who has had any experience in road maintenance knows it should not be attempted by any but experienced men because it is one of the easiest ways known to waste money. Just what to do to a road in certain stages of deterioration is one of the most difficult things for even the most experienced engineers to determine.

I have seen some men use 500 cu. yds. of stone to the mile and make less showing and do less good than an experienced man would with 100 yds. of the same material.

It has always occurred to me as being peculiar that separate accounts have not been kept, showing the expenditures which have been made on a road; today it would be impossible to go to any county in this state and find the cost of a single mile of road unless that mile had been built under state supervision where cost records are accurately kept. It is part of the training of an engineer to analyze costs, to segregate costs so that they know not only the original cost of any improvement but also what it has cost from year to year; only by keeping and knowing such things can we ever be certain that we are doing economical work.

Road Building an Engineering Problem

I have endeavored to show that every phase of road building is an engineering problem and the sooner that fact is realized the sooner will the taxpayers be properly protected. But the thing I am contending for will not come over night. Men without any knowledge of the subject will be elected to office on some fake issue and will continue to build roads according to their own pet theories, many of which will be at variance with good engineering, but the taxpayers should remember that they are paying for all mistakes made.

Noted men have made the statement that of the 300 million dollars expended in this country on roads last year that at least one-third was wasted, and it is now time for the people to take this matter in hand and see that not a single piece of road work is attempted unless done by skilled engineers; then every cent expended on location will be a permanent investment, every fill and every cut that is made will be properly done, every bridge and every culvert built so that it will carry the loads that pass over the road. The type of surfacing used will be the most economical one, and the roads when once built will be maintained instead of being allowed to deteriorate from day to day. Every cent expended will be properly accounted for, and then and only then will the taxpayers realize a dollar's worth of work for every dollar of their money invested in roads; when such times shall come the people will be willing to pay taxes for roads, because they will see that their interests are properly safeguarded, and we will have more and better roads at a cheaper price.

Construction Procedure in Repaving Detroit Avenue, Lakewood, Ohio, with Granite and Wood Block

That part of Detroit avenue in Lakewood, Cleveland, Ohio, or the three miles from 117th street to Rocky river, is being repaved.

In the earlier days of the city, this was an old plank road with a toll gate where the city hall now stands. When the present pavement was laid, Detroit avenue was considered one of the most prominent and serviceable of Greater Cleveland's traffic-ways. Of late years, due to motor truck and other heavy transportation, the street surface has been so badly damaged that improvement was absolutely essential.

The two miles from 117th street to Cranford avenue will be paved with 5-in. granite block and the remaining mile to Rocky river with wood block. The section in front of Lake-

VIEW OF GRADE AS LEFT BY STEAM SHOVEL ON REPAVING OF DETROIT AVENUE, CLEVELAND.

wood hospital will be wood block because of its being less noisy, and the section at Rocky river around the street car curve will be granite.

The work was divided into three sections in awarding contracts. Roehl Brothers obtained Section 1 at a bid of $98,136. The Enterprise Paving Company, Section 2, at $118,522. Baldwin Brothers Section 3, at $113,973. Being handled in three sections by three different contractors and two kinds of material, speedy results are hoped for. Each of these contractors depends on Thew shovels in road and street excavation.

Section 1 operations were the first started, on August 22d, when Roehl Brothers' Type AO broke ground at 117th street.

The width of the street excavated on each side of the car track was 12 ft. The depth of cut varied from 12 ins. at the track to 18 ins. at the curb. This meant, then, that when the shovel finished subgrading on October 10th it had removed some 6,600 yds. of earth, old macadam foundation and asphalt. Counting actual working time, it averaged about 300 lin. ft. daily, despite having to suspend operations frequently to let street cars pass. Capacity was further limited by a long haul of the excavated material and inability of dump wagons and motor trucks to transport full output steadily.

The view shows the perfect grade left by the shovel, so that subsequent operations could follow right along. It illustrates clearly the worth of the Thew horizontal crowding motion. Leaving the sub-grade true eliminates the time and expense of a gang of hand-laborers to put on the finishing touches.

Other time and labor saving features observed in operating this shovel were powerful prying dipper action and swivelling dipper arm. By means of the first, the heavy, compact material was readily torn up and removed. The swivelling dipper arm enabled digging around sewer and telephone conduit manhole covers and immediately alongside the curbstones.

Fire hydrants and telephone conduits were put in promptly to avoid tearing up the street later on. Conduit trenches were dug and the back-filled material tamped, respectively, by a Pawling & Harnischfeger excavator and tamper.

The concrete sub-base for the new pavement is 6 ins. thick, the concrete being mixed by a Foote mixer. The granite blocks are rolled by a Kelly-Springfield steam tandem roller.

Protecting Water Mains, Fire Hydrants and Valves Against Freezing in Winnipeg, Manitoba

By Thomas H. Hooper, Operating Superintendent of Water Works, Winnipeg, Manitoba, Canada

Fire hydrants in the city of Winnipeg are installed for fire-fighting purposes only, to be used by the fire brigade in fighting fires. The climatic conditions are very severe, the cold in winter sometimes dropping to 40 or 45 degrees below zero. It is during this season that the work of this particular branch becomes heavy. The fact that the firemen of this city have never found a hydrant out of commission when required, through being frozen or from other causes, has been brought about, primarily by a system of daily inspection in the downtown portions and congested areas, tri-weekly in the adjoining districts, and bi-weekly in the outer portions of city, writes Mr. Hooper in the Quarterly of the National Fire Protection Asociation.

Hydrants

All hydrants immediately after use in winter seasons are repacked with a compositon of tallow and hemp packing, placed in the stuffing box in hydrant head; otherwise the operating nut would be frozen solid and the hydrant placed out of commission. Occasionally, through a faulty drip, the water will rise in the post, when a steam boiler is used for the purpose of forcing steam into the post to thaw it out.

When a hydrant is found out of repair, the fire brigade is notified at once, and when placed in commission the brigade is informed. All repairs to hydrants are treated as emergency jobs, and workmen stay until repairs are completed.

Hydrant repairs are divided into two classes, light and heavy. Light repairs consist of repacking, renewing bolts or nuts, and renewal of parts which can be made without digging out the hydrant. Heavy repairs are occasioned through foreign matter being drawn into the hydrant, such as sticks or stones which have been left in mains at time of construction or the breaking of post or valve.

It is most essential that in laying water mains it should be the duty of some man to inspect each pipe as it is laid, and at night when men lay off work to block the end securely to prevent children from throwing stones in the pipes.

Hydrants are placed at approximately 300-ft. intervals on all new mains laid, the water works receiving an income from the city at large of $30 per hydrant per annum to offset the water consumed and the maintenance of the hydrants.

Considerable trouble was experienced in past years, owing to unauthorized persons operating hydrants, using at times alligator wrenches or large monkey wrenches, and in doing so stripping the edge off the operating nut, which is pentagonal in shape. The writer was successful in having a by-law passed, making it a misdemeanor for any one (except the fire brigade) to use a hydrant without first securing the permission of this department.

Valves

There are in use in this city at this time 2,360 hydrants and 4,005 valves on domestic service. Valves are inspected the same as hydrants, as it is necessary in case of a break during a fire to localize the break by shutting off the least possible length of main.

Valve repairs are far more frequent than hydrants, caused generally from broken bolts, broken spindles or foreign matter such as sand, stones or sticks blocking valve so as to prevent it being properly closed when required.

The fire service water works system or high pressure which is supplied with water from the Red River receives the same close attention as the domestic system, there being 158 hydrants and 298 valves.

Water Mains

Water mains in this city are laid at an average depth of 7 ft. 6 ins., and in spite of the intense cold, frozen mains are almost unknown. Last year a main in an outlying district was found to be so nearly frozen that only a small stream could be secured at the hydrant. The hydrant was left open, when the water gradually cut the ice away and in time freed itself.

The only other case the writer remembers was where a 10-in. main was frozen solid. To free this main, it was necessary to make four excavations at a distance of 40 ft. apart; the main was then tapped with 1-in. holes and thawed out with steam from hose inserted in the holes.

If water mains were laid properly in the first place there would be very few repairs required except in the case of electrolysis.

The writer had occasion recently to cut out some sections of cast-iron water main which had been in service for the past 34 years, when it was found that the pipe and asphaltic covering was in just as good condition as when laid, there being not the slightest trace of wear. Therefore, if joints were properly made and pipe sufficiently tested prior to laying, there would be very little interruption in the distribution system, guaranteeing a full supply when called on in case of fire.

High Efficiencies Shown by Motor-Driven Water Works Pumps at St. Paul, Minn.

Many pumping problems are most conveniently solved by electric-driven pumps. Such pumps constitute a peculiarly desirable load for central stations, as they operate either at full load continuously, or in some cases are operated only during periods of light load, thus helping to fill up the "valleys" in the load curve.

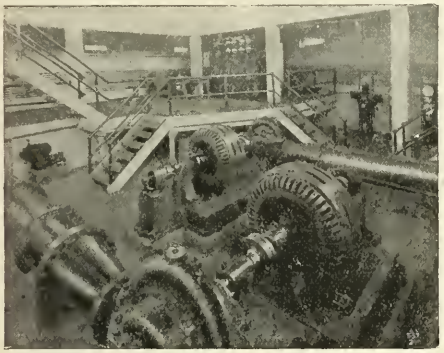
Where centrifugal pumps are operated by power purchased through a meter, careful attention is likely to be given to efficiency, as a few points gained in efficiency will in a short time amount to more than the cost of the pumps. The figures showing efficiency and other characteristics of two 12-in. motor-driven centrifugal pumps herein given are taken from a report made by J. W. Kelsey, principal assistant engineer to

G. O. House, former general superintendent of the St. Paul Water Department, and relate to equipment recently installed at the McCarren Pumping Station.

Specifications

The specifications required that each unit should be guaranteed to deliver not less than 5,000 U. S. gals. per minute against a total head of 171 ft., and not more than 5,500 gals. per minute against a total head of 158 ft., the overall efficiency from "wire to water" to be not less than 72% when pumping continuously at either of the heads and deliveries. It was further required that when delivering against a reduced head of 140 ft., the motor should not be overloaded.

The bid of the Northwestern Electric Equipment Co., of St. Paul, which was accepted, offered pumps manufactured by the De Laval Steam Turbine Co., of Trenton, N. J., and synchronous motors of the rotating field type, manufactured by



DE LAVAL MOTOR-DRIVEN CENTRIFUGAL PUMPS, McCARREN PUMPING STATION, ST. PAUL WATER WORKS.

the Electric Machinery Co., of Minneapolis, and guaranteed an efficiency of 74.3% at heads of either 158 or 171 ft., and an overall efficiency of 73.7% at 140 ft.

Motors and Pumps

The motors receive three-phase, 60-cycle current at approximately 2,200 volts and drive the pumps at 1,200 R. P. M. They are so designed that they can be started by the application of alternating current to the armature windings. In normal operation they are supplied with exciting current by directly connected exciters of 1¾ kilowatt capacity.

The pumps are of the De Laval single-stage double-suction volute type, having 12 in. suction and discharge nozzles. No diffusing vanes are used.

Making the Tests

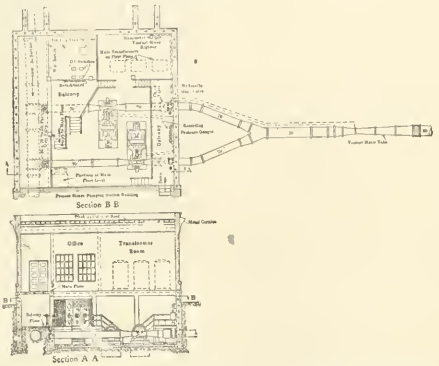
TABLE I

Efficiency and Other Characteristics of Two 12-in. Motor-driven Centrifugal Pumps, McCarren Station, St. Paul Water Works.

Motor 403115, Pump 25650				Motor 403129, Pump 25651				
Volt meter	2230	2230	2240	2240	2250	2260	2270	2295
Rec. watt hour meter	234.0	225.0	210.0	165.0	224	217.4	204.8	188.1
A. C. ammeter..	62	59.5	55.5	44.5	57.6	56	52.4	47.8
P. F. Indicator %	100	100	100	100	100	100	100	100
Ind. wattmeter...	233.3	226.2	210.1	165.3	226.3	220.2	206.0	188.9
Vent. manometer	9.75	8.50	7.25	4.60	9.4	8.24	7.1	5.9
Press. gage ft....	147.25	165.25	179.25	195.75	146.5	163.0	176.5	186.0
Suc. gage feet Press.	4.0	6.0	7.5	10.0	3.2	5.0	6.5	8.0
Total head ft....	143.25	159.25	171.75	185.75	143.3	158.0	170.0	178.0
R. P. M.....	1220	1220	1220	1220	1220	1220	1220	1220
G. P. M.....	6771	5900	5035	3194	6527	5722	4930	4097
Water H. P.....	245.1	237.5	218.4	150.0	236.4	228.7	211.9	184.3
Electrical H. P..	312.9	303.3	282	221.7	303.4	295.2	276.1	253.1
Overall efficiency	78.4	78.3	77.7	67.7	78.0	77.5	76.4	72.8
B. H. P.....	298.5	289.6	269	209.9	289.0	280.8	262.2	239.3
Pump efficiency..	82.2	82.1	81.2	71.5	81.8	81.5	80.7	77.0

After installation both units were subjected to very complete tests to determine both efficiency and head-capacity characteristics. Before the official tests were run the impellers had been turned down slightly in diameter, due to the fact that the motors were operating at 20 R. P. M. above rated speed.

Before beginning the test, the pressure gauge of each pump was taken off and calibrated on a dead weight testing instrument, and then replaced, the pump stopped and the static head of water determined by finding the elevation of the center of the gauges and the elevation of the water in the high service reservoir. The head determined from the elevations was found to agree with the calibration obtained with the dead weight testing instrument. The readings of the suction gauges were also checked against elevations in a similar manner, and found to be correct. As they registered zero with no pressure and as the variation in head was never more than 10 ft., it was assumed that readings of the gauges between zero and 10 ft. would be proportional.



PLAN AND LOCATION OF McCARREN PUMPING STATION, ST. PAUL, SHOWING LOCATION OF MOTOR-DRIVEN PUMPS.

The quantity of water delivered was measured by a 30 in. by 13 in. Venturi meter, supplied by the Builders Iron Foundry Co., of Providence, R. I. The recording instrument supplied with this meter includes an indicating dial, a recording card and an integrating counter, but in order to verify the accuracy of its readings, an indicating mercury manometer was also connected to the pressure pipes of the Venturi tube.

The electrical measuring instruments were checked and calibrated subsequently by comparison with standard instruments by representatives of the Northern States Power Co.

In running the test, the head against which the pumps worked was controlled by means of a hydraulic gate valve on the discharge side of the pumps. After throttling the gate valve, no readings were taken until all instruments had ceased fluctuating, after which two or three readings were made and averaged, if any variations were found. Observations were made with the pumps operating under four different heads, covering a wide range of delivery.

Results

The results obtained on the official test are shown in Table I. In computing the efficiencies of the pumps alone, motor efficiencies, as obtained on tests of the motors by the University of Minnesota, were used. On motor No. 403115, the following efficiencies were obtained:

Full load 95.5%, ¾ load 94.9%, ½ load 93%.

Motor No. 403129 gave the following results:

Full load 95.3%, ¾load 94.6%, ½ load 92.5%.

The test results of the units show the variations in head and capacity at constant speed together with electrical horse power input and overall efficiencies.

The efficiencies obtained on these pumps are quite high, considering the comparatively small capacity and the high head. Many builders would advocate the use of diffusing

vanes for such conditions, which, however, would make the pump more expensive and complicated without any gain in efficiency. The efficiencies are further very high over a considerable range in capacity. Take, for instance, pump No. 25651, which at a capacity of 6527 G. P. M. shows an efficiency of 81.8% and at 4097 G. P. M. an efficiency of 77.0%, or for a reduction in capacity of about 37%, there is a reduction in efficiency of only 5.9%, which must be considered very good for a centrifugal pump.

The pumps deliver slightly more than 5500 G. P. M. at 158 ft. total head, but this was not at all objectionable, due to the fact that the efficiency was very high also at low heads, which in this particular case was of great advantage, as can be seen from following quotation from the official report:

"As to the quantity of water pumped, it will be observed that it more than meets the requirements of our specifications. The clause in our specifications limiting the quantity of water to 5,500 gals. per minute when working against a head of 158 feet, was inserted to insure a high efficiency at this pressure. It was our belief that the maximum efficiency would be obtained when pumps were working against a much higher head. Fortunately, however, the reverse is true, and our pumps are delivering a greater quantity of water, with a higher efficiency than was anticipated at the lower heads.

"The friction loss in our force mains is less than computed, with the result that our operating head is somewhat lower than provided in our plans, which explains one of the main reasons for reducing the effective diameter of the impellers. The consequence is a greater quantity of water, at a higher efficiency against our prevailing dynamic heads."

Relation of Main Drainage to River and Harbor Front Improvements in Various American Cities

By Morris Knowles and John M. Rice, Engineers, Jones Bldg., Pittsburgh, Pa.

Some of the notable American projects for river and harbor improvement, involving questions of main drainage, are here described with special reference to the methods adopted for eliminating the nuisance caused by the discharge of raw sewage. The data and discussion are from a paper by Messrs. Knowles and Rice before the American Society for Municipal Improvements.

Baltimore

Before the present system of main drainage was put into effect, Jones' Fall River which traverses the center of the city, afforded the most available means of draining the districts tributary to it. The collection of offensive matter in its open channel had been for many years a source of continued nuisance and expense. The winds were the most powerful agency affecting the regimen of the harbor. A heavy southeast wind raised the water 6 ft. above mean tide, while on the other hand, a strong northwester would drive the water out of the river, leaving it some 5 ft. below the mean.

Under these conditions whatever solid matter was permitted to enter the harbor remained there sinking to the bottom or floating on the surface, but never getting far away from the point of entrance; so that sewage and other filth allowed to enter the harbor with storm water, were not finally disposed of, but continued as a source of nuisance and after befouling the harbor and silting up the channels, the accumulating matter had to be removed by dredging.

The pollution of the harbor waters was also a matter of concern to the great oyster interests of Baltimore. This led to many investigations as to the best methods of disposal and treatment.

The system finally adopted and built after the fire which destroyed a large part of the city was that recommended by the sewerage commission of the city of Baltimore in its 1897, 1899 and 1906 reports.

The separate system was adopted, collecting the domestic sewage of the city into a high and low interceptor, the sewage being pumped from the lower to the higher at a suitable point. The works are situated about 4½ miles east of the city boundary on the shore of the Back River. The process of disposal comprises sedimentation, screening, sprinkling filters and subsequent settling basins.

New Bedford, Mass.

With few exceptions the New Bedford sewer outlets were located near the shore line, often at the end of docks, where the current movement of the water was slight.

The pollution of Acushnet River and Clark's Cove by the sewage had given rise to such nuisances along the city's water front that plans for an intercepting sewer system and pumping stations to care for the entire flow of the municipality were prepared in 1910, and the work completed in 1913.

The intercepting sewer was built with an outlet into the harbor at a point far from shore where the rate of dilution is great enough to avoid nuisances.

Cleveland

The city of Cleveland is ideally located for drainage by a gravity system of sewers and for sewage disposal by dilution, since the Cuyahoga River and its tributaries on the one hand and Lake Erie on the other, afford convenient outlets for all sewers of the city. But on account of the very low velocity of the river, the bottom is covered with a heavy sewage deposit, much of which, at the time of the spring freshets, was washed out into the lake, where, at times, it was possible for it to contaminate the water supply.

An intercepting sewer system was therefore designed for the purpose of intercepting the dry weather flow of all sewers emptying into the river, its tributaries and the lake, and conveying this flow to an outlet located on the shore of Lake Erie at a safe distance to the east of the new water intake, where it is proposed to treat it before final dispersion in the lake.

Toronto, Ontario

Toronto offers a good example of the relationship of main drainage to waterfront development and improvement.

The sewage of Toronto, before the new system was built, was collected by the combined system and discharged at various points in Toronto Bay without treatment of any kind, with the result that nuisances had been created along the water front especially during the warmer months of the year. This also constituted a danger to the source of water supply of the city.

The sewage disposal problem of Toronto is important from the aesthetic as well as from the sanitary standpoint, the bay being used to a large extent for sailing and bathing. At the outer boundary of the bay known as the Toronto Island, a great number of residents of the city have established summer homes and the pollution of waters by sewage tended to destroy the value of this property as a site for summer cottages. A number of amusement parks on the water front also suffered from pollution of the bay by sewage.

The main drainage system comprises high and low level intercepting sewers, an electrically operated pumping station for the low level flow, a screening and sedimentation plant and a submerged outfall line extending into Lake Ontario.

Syracuse, New York

The city of Syracuse, New York, is drained by two streams which flow in a northerly direction through the city and discharge into Onondaga Lake. Two streams, Onondaga Creek and Harbor Brook, served as carriers for the entire storm water and sewage of the city which are collected on the combined system.

When the loading of the streams with an excessive amount of sewage exhausted the supply of dissolved oxygen in the water and the odor from the putrefaction of the organic mat-

ter became objectionable a system of main drainage was designed to do away with the nuisances caused by these conditions. The main intercepting sewer built in 1910 and 1911 ran along Onondaga Creek carrying the flow from the combined system of sewers to a temporary point of discharge into the creek in the northern outskirts of the city.

Another interceptor was built along Harbor Brook, on the same principle of design of the main interceptor, but much smaller.

Washington, D. C.

The sewerage of the Capitol City may be said to date from 1871. In course of time various defects developed and there were complaints from odors due to lack of ventilation and from pollution of the water courses.

In 1890 storm drains were constructed in the low lying sections, the polluted canals were filled and intercepting sewers were built to deliver the sewage to a central pumping station on the Anacasta river. From this station the sewage was carried by three siphons for a distance of 2,680 ft. under the river, and thence by an outfall sewer 15,483 ft. long along the Potomac to an outlet discharging at the bottom of the river about 500 ft. from shore.

Cincinnati, Ohio

The extension and growth of Cincinnati forced the city authorities to plan and construct a system of main drainage which would answer the present and future needs of the city for a number of years.

The sewage of Cincinnati was discharged untreated into the nearest available water courses, namely, Mill Creek, Duck Creek and Ohio River, through several outlets.

About 65 per cent. of the sewage was discharged into Mill Creek and Duck Creek, the remainder finding its way into the Ohio River. As a rule the outlets into the Ohio River had not resulted in any offensive condition. Along Mill Creek and Duck Creek a system of intercepting sewers in the valleys of these streams was planned, and construction was started in 1912 and 1913.

Plans for an interceptor following the Ohio River banks as well as a comprehensive system of sewerage considering the future extension of the city were also laid out.

Through the construction of two intercepting sewers, sewage was to be removed from Duck Creek and Mill Creek, and thereby eliminate odors and offensive unsanitary conditions.

A section of Duck Creek was to be eliminated through the construction of the Duck Creek interceptor, thus allowing the reclaiming of the creek bed for park or transportation purposes. Mill Creek was to be confined between masonry walls thus permitting the reclamation of bottom lands for industrial purposes.

Waterbury, Conn.

The sewerage system of Waterbury, Conn., a city of 74,000 in 1910, consisted of a considerable number of relatively small drainage districts, the sewers of which were designed to discharge into Nangatuck River or its nearby tributaries.

While special conditions of the river near the city prevented any putrefaction and resulting nuisances, putrefaction was active at a point about 3 miles from the city and marked nuisances resulted from these conditions.

As a remedy for these unfavorable conditions, the construction of an intercepting sewer and sewage purification works were planned and carried to conclusion. There were many interesting features governing the design of the sewer section.

The sewer line for a distance of a third of a mile is located either along the precipitous slope of the river bank or in the bed of the stream and throughout this distance the sewer structure has been so located, designed and constructed as to form a foundation for the lower portion of a retaining wall to be subsequently built for the reclamation of a considerable area of the low level lands now subject to flood inundation. The governing conditions were most favorable for the adoption of a design for a dual purpose structure, and the lands to be reclaimed are of great value for manufacturing purposes.

The saving in total expense effected through this design is estimated to be, at the completion of the river wall, fully two-thirds the cost of the present sewer structure.

For three-quarters of a mile through the site of the proposed sewage purification works, the main intercepting sewer has been built in conjunction with a filter effluent conduit and two pressure mains.

The main outlet sewer running along the bank of Nangatuck River was given permanent protection against the erosive action of the stream through the construction of slope paving.

This work shows how the main drainage problem of a comparatively small city can be handled efficiently in connection with river front improvement.

Harrisburg, Pa.

The discharge of crude sewage through a number of outfalls along the Susquehanna River front at Harrisburg, Pa., had resulted in the creation of objectionable conditions along the shore, for in most cases the outfall lines were not carried out to deep water and were often above the water level in the river.

The sewage, therefore, instead of being carried out and away quickly by the current tended to pool and stagnate close to the shore line, and as the city's streets extend almost down to the water front there were many complaints from residents whom the unsanitary state of the river affected, especially during the summer months. To remedy these conditions the city has built an intercepting sewer to collect the flow from the old outfalls at the end of each street, and deliver it through a single submerged outfall into deep water downstream from the city where the current is swift enough to assure a good degree of dispersion.

Ultimately all the sewage from this interceptor and others to be built will be conveyed to an island in the river and will be treated there at a sewage disposal plant.

Conclusion

Many other examples could be cited of cities where the improvement of the water front was largely dependent upon improvement of the sewerage system, but it is believed that sufficient proof has been given to show the dependence of the former upon the latter.

The lesson to be drawn from this is obviously that even in the younger and smaller communities where nuisances do not yet exist from the discharge of raw sewage into the adjacent waters foresight requires that sanitary sewer systems be designed with a view to ultimate interception to remove offensive material from the waterfronts.

Street Cleaning in Pittsburgh, Pa.

The accompanying views illustrate street cleaning methods in vogue in Pittsburgh, Pa., and were furnished this magazine by John F. O'Toole, superintendent of street cleaning in that city. As the views indicate, while mechanical devices are employed, they have not rendered entirely obsolete the man with the broom.

Under favorable conditions a great deal of man-power can be replaced by the use of mechanical devices, but Mr. O'Toole states that many conditions may be cited under which no known mechanical pick-up device could provide the degree of cleanliness that modern city life demands. In the congested business sections of any large city the traffic conditions are such during the major portion of a 24-hour period that no mechanical device can insure satisfactory service.

Mr. O'Toole's views on this point were further expressed in addressing the Society for Street Cleaning and Refuse Disposal of the United States and Canada, as follows:

"This in a measure would also hold good in many high-class residential sections, especially since the general use of the automobile, where street after street is occupied temporarily by these automobiles for parking purposes during many hours of each day. While it might be said that in sections such as this and other more remote residential districts the work of cleaning streets could be performed better during the night, there again we are met with objections from residents who complain that their evening's recreation in the vicinity of their homes is destroyed during these operations, and if operations are suspended until a later hour, objections are again entered by these people on account of our disturbing their slumbers.

"All these conditions indicate that the man with the broom cannot be entirely done away with, and that no matter what mechanical devices are used, we must rely upon this manpower to maintain at all times an efficient street-cleaning organization. The modern standard should provide for the constant cleanly appearance of the street, and this standard cannot be maintained by mechanical devices alone.

"Pick-up devices, under favorable conditions, will no doubt lessen the cost per cubic yard of material removed, and also lessen the cost of area treated, but there are so many factors to be considered in the problem of cleaning and keeping clean the streets in a large city that any reduction in the cost of doing this work by appreciably lessening the man-power, especially in the patrol service, would be balanced at times by the unsatisfactory measure of cleanliness effected."

VIEWS ILLUSTRATING STREET CLEANING METHODS AND EQUIPMENT EMPLOYED IN PITTSBURGH, PA.

Practical Measures for Securing Greatest Economy in Public Utility Plant Operation

By Charles Brossman, Member American Society C. E., American Society M. E., Consulting Engineer U. S. Fuel Administration on Utility Plants in Indiana, Indianapolis, Indiana

V. Proper Use of Recording and Indicating Instruments

The subject of instruments for obtaining efficiency in the power plant was discussed in Article IV of this series, see pp. 111 to 113 of Municipal and County Engineering for September, 1918, and the present article treats of another phase of the same subject.

The proper use and results of power plant recording and indicating instruments is largely determined by the point of view of the man using them. Take a pair of opera glasses or a telescope and look through the big end at some nearby object. Things look a tremendous distance away and out of reach and unattainable. Reverse the instrument, looking through the proper end and things almost hit you in the face when they are really far distant.

Now, don't look at things through the wrong end and if you do, reverse quickly and get the proper view of what instruments can do for you. Recording and other instruments properly used will give you a view of your plant operation that you could never attain in any other manner.

Operators Must Use Instruments Properly

There has been a great development and increased use in devices and instruments for recording, indicating and measuring the various necessary forms of power, water, etc., in utility plants, but the drawback is that many of the operators have not kept pace with the development of such devices. The attitude of the man who is to use the instrument is more important than the instrument itself. The instrument will not increase the economy of the plant; it is only going to show you whether you are operating to get the best results. The balance of the work is up to you. This is a very serious question as is evidenced by what has happened in quite a number of plants. I have come across many places where there were instruments for recording, indicating and various uses, that were standing unused, unoperative, and no desire was shown to use them, or even to say a good word for them.

Some allowance must be made for a few of the earlier instruments, there is no question as to that—but on the whole, in many plants there is something lacking. The operator had not had the proper interest and this may have been due to several reasons. It may have been too much trouble—it may

be ignorance or something else, but ignorance cannot be the excuse of the man who really wants to know. If the man who does not care is in a rut, he can be pulled out, but he must keep up steam and go on his own power after he is out.

Small Plant Conditions

In the larger stations these matters are largely overcome or provided against, as men are especially engaged to do the work of looking after the instruments of this character and are constantly endeavoring to increase the plant efficiency. These men of course keep all records and keep the devices in good shape.

In the smaller plant it is not possible to get expert supervision, neither is it necessary, but the results and the success or condemnation of such instruments rests entirely upon the intelligence and attitude of the engineering force.

It is therefore necessary for the owner, superintendent or whoever may be in charge to see that the proper interest is maintained. There is no use getting these instruments to be laid away and get covered with dust. Among practical means to get results that of first importance is to get the interest of the entire force, so that they will take care of and use the instruments. Keep the men interested by getting up good natured competition.

The Bonus System

If necessary to get results offer a bonus to increase over all results and efficiency. If you can save something each month by a bonus system—why not do it? You will be money in pocket and what the working force will get will depend entirely upon their results. You will not get maximum results or full benefit until the men in the plant realize that what you are striving for is better operating conditions. Furnish the men plenty of information—I think most men, engineers and firemen included, are trying to better themselves or would try if given the chance. There are many chief engineers and good ones, who have started in firing.

The man at the head must have the proper interest and must show the men under him that he has. If the interest is not in the man at the top it certainly will not be evidenced by the rank and file.

Some one has said social, economic and political reforming will finally resolve itself into just a plain job of cost finding. Right there is the basis of success of the modern utility plant. I want to mention a few things that I have found in some plants.

Some Examples of Plant Neglect

In one I was shown through in company with some officials—here were the boilers with draft gauges on each boiler and not a drop of water in a gauge—all covered with dust and some of them broken.

In the rear of the boilers were gas collecting devices. I asked if they used them, and was answered, "No." I asked if they had an indicator and how often it was used: "About once a year." There was a steam flow meter, but it was not used. Records were kept of some things, but with all that was done, it could not be determined what amount of coal was used per unit of power.

In another plant furnishing water and light the water pumped per year was only guessed at. Yet in the station was a Venturi Meter with its full equipment not being used at all. Inquiring for station records, I found that one progressive engineer had been keeping them, but had been ordered to stop. In another were full instruments for recording loads, etc., yet the engineer did not use them because he was out of glass pens—too much trouble to buy them—(they cost about 25 cts. each). The plant was well kept up, too, but no one knew actual costs as to whether they were too high, or if properly apportioned.

Instruments Are Not Unfriendly Spies

Don't let your men get the impression that instruments are for the purpose of keeping tab on them. The main function of these devices is to help you operate at minimum cost and keep your plant at its best. As soon as your plant was built depreciation and wear started right in—you want to know if things are not keeping up as they should and instruments of the proper kind will tell you. Get the men to see that operating the plant at its best is to their credit—that is one object you are after. You also want to know yourself, your advancement will depend on what you do and the results you get.

This is a big problem in many plants, although it is not as hard now as formerly, but it is necessary to get full cooperation from your men and have them interested and then all will get the full benefit.

The work will be easier for the men and better operating results will be obtained—"He profits most who serves best" holds in the engine and boiler room as well as in any other walk of life.

Now the smaller sized plants are the most affected by the lack of knowledge and it is confined to both private and municipally owned plants. I am going to illustrate what this lack of knowledge means by some actual examples that I have come across.

It Costs Money to Remain Ignorant and Indifferent

In one plant supplying two kinds of service a petition had been made for higher rates. Investigation showed that anywhere from 14 to 20 lbs. of coal were used to generate a kilowatt. This plant generated the electric power and also pumped water by electric power and the coal used in pumping was somewhere from 15 to 20 lbs. of coal per 1,000 gals. pumped. No records were kept and no one knew anything definite about the plant. There was not even a draft gauge on the boiler furnace, even though they knew their coal was running 30 to 40 per cent. higher than it should; everyone connected with the plant realized that something was wrong, but no one moved a finger to even adjust or put in shape what they had. The publicity to all connected with the plant threw a mantle of ridicule over all concerned in the plant's operations, which might have been corrected by the use of a little common sense.

In another plant where quite a few kinds of utility service were given, some records were kept, the men at the plant filled them in a perfunctory way and sent them to the office. At the office on inquiry I asked for certain data; the superintendent said he did not have it. I asked for his station logs and he gave them to me, and I found the most of what I wanted; enough to show me where the trouble was. The superintendent did not know what was on his log sheet and made no attempt to get any use from what records he had. The logs were bundled up and put away and that was the last of them and no attempt was made to have them serve any useful purpose. The result in this case was a great deal of trouble for the company, which would have been averted if they had known their plant as they should.

In another plant, not much larger than the former plant mentioned, every record was kept and curves and loads plotted by the superintendent. He could show you the load or fuel consumption for any period on a few minutes' notice. His rate was considerably lower than the other plants and his operating costs much lower than the other plant mentioned, even with all allowances for difference in equipment and size; he was keeping out of trouble when the other fellow was not—he knew just what his plant was doing and what it could do at its best and he kept it there. The man who was having all the trouble could have kept out of it had he taken the proper interest in knowing his plant and its records.

Here are two towns I know of, one of them five times the size of the other, both pumping water under almost similar conditions—yet the coal used is almost the same amount per

year in each case. The boilers are the same type and pumps are the same type. The smaller plant uses almost 25 lbs. of coal per 1,000 gals. of water pumped, single pumpage from well to system. Again a case of no records to show why costs had been increasing all the time. These are just a few things to the point and showing what results can be expected where ignorance of plant conditions prevail. If you do not know what your plant is doing, whether it is doing all it should—doing its best—it may lead to trouble for you. Therefore, start in and study your conditions—start to analyze your plant and find out what you know least about in your plant. When I say least, I mean actual definite data. Trace each part down and find out where information is really lacking, then decide what you need in the way of instruments and devices to keep you posted in such a way that you can tell at any time just what you were doing. You will find it is interesting—that it will pay, and be a source of satisfaction—especially when the time comes when you have to submit this information for some important reason. Again, don't be ignorant of your plant operation costs. Voluntary ignorance is just as bad a fault as voluntary idleness. Get the "key" to your plant and keep it.

Investigations of Pipe Corrosion in Chicago Buildings, with Special Reference to Durability of Pipe Materials

By Thomas J. Claffy, Assistant Chief Sanitary Inspector, Department of Health, City Hall, Chicago, Ill.

It has been observed for some time by those in close touch with plumbing installations in Chicago and elsewhere that under certain conditions, iron pipe is affected seriously by rust. The corrosive element, whatever it may be, seems to have more effect on one kind of pipe than on another, and also to be worse in some buildings than in others. In previous investigations, conducted by the Research Committee of this society, special attention was given to the house drains and sewers, said Mr. Claffy in addressing the American Society of Sanitary Engineering.

Chicago Investigation

It occurred to the author some months ago that a little attention should be given the pipe in the system above the basement or cellar floor and so, about May, 1, 1918, a man was assigned to make a canvass of that portion of the downtown section of Chicago, covering LaSalle, Clark and Dearborn streets, between Randolph and Van Buren streets. In this section we find nearly all of the large office buildings, several banks, and the municipal and county buildings; also the U. S. government building, which contains the post office and federal courts. On account of war conditions, the investigation did not include this building. We aimed to confine our attention to buildings of 6 stories and upwards, and over 5 years old. One or two less than five years were included because of the conditions noted in buildings very close to that age.

Cast Iron Pipe

Cast iron pipe has been recognized for many years as a very durable material for soil, vent or drainage purposes and consequently has been much used in building construction and, no doubt, its use will continue. When construction of buildings over 6 stories high began, a new epoch was introduced in building construction and we very shortly had buildings twice that height and higher.

Screw Pipe

About 30 years ago began the common use of screw pipe in plumbing systems in such buildings. At that time it was a novelty, and with the introduction of drainage fittings appeared what was known as the Durham System. Because of the fact, noted in recent years, that there is a great deal of corrosion in pipe systems, it was deemed expedient to find out, if possible, the relative merits of cast iron, wrought iron and steel pipe in such systems.

Method of Investigation

In making this investigation, the inspector was required to report on the height and age of each building separately; the number of vents at the roof line; size, and whether pipe was cast iron or screw joint; to obtain a sample where possible for test purposes, and under the head of "Remarks" to describe such conditions as were found. Photographs were obtained of sufficient vents on the roofs to show an existing average of their condition. The inspector also was required to state whom he interviewed, whether the owner, superintendent, engineer, or other person. In order to distinguish between wrought iron and steel pipe, it was necessary to take samples for test, filings being obtained for chemical tests and pieces of the pipe for fracture tests. In obtaining filings the outside skin, which was generally either a heavy coat of paint or a coat of rust, was filed away and filings of the clean metal procured. These samples were sealed in an envelope and numbered, the number on the envelope corresponding with the number on the report describing its condition, together with the name of the building.

Chemical Test of Pipe

All samples were tested by the so-called manganese test, a very simple qualitative chemical analysis which may readily be performed by anyone having the necessary inexpensive outfit.

In the manufacture of steel pipes, it is well known that to the molten metal in the Bessemer retort, a certain amount of Ferro Manganese is added in order to make it possible to roll and weld the over-oxidized metal. There is no such addition of manganese in the manufacture of wrought iron. The latter metal contains only a very insignificant amount of manganese, such as may have been contained in the original ore. In making this manganese test, each sample of filings is placed in a glass test tube. The amount need only be a few grains. To this is added 10 drops of nitric acid, diluted with an equal part of water. The solution is then heated for a few seconds over a flame and allowed to cool off. When cooled a small amount of sodium bismuthate is added. If the sample is steel a decided pink color will show. If it be wrought iron the solution will show a light brown color, which gradually fades away, leaving a brownish residue in the bottom of the tube. In several cases, these tests were supplemented by fracture tests, which furnish a conclusive check on the manganese test. Wrought iron fractures show a fibrous character of metal, and steel a brilliant crystalline one. For the purpose of this investigation the tests outlined answered the purpose.

Data Collected

The tables herewith contain a brief summary of the data collected, showing the age of pipe installation, the total number of roof terminal vents, number of screw pipes tested, to determine whether of wrought iron or steel and the condition of all pipes with respect to corrosion at time of investigation.

Age of Buildings and Pipe

Altogether, 63 buildings were investigated, in all but two of which more or less complete data was obtained. In age these buildings range as follows:

30 years up	13 Bldgs.
25-39 years up	18 Bldgs.
20-24 years up	5 Bldgs.
15-19 years up	3 Bldgs.
10-14 years up	13 Bldgs.
9 years or less	11 Bldgs.
	63 Bldgs.

Kind of Pipe

Dividing these buildings according to the kind of pipe used

in their drainage systems, we find

1.	Cast iron in.....	15 Bldgs.
2.	Wrought iron	8 Bldgs.
3.	Steel.	18 Bldgs.
4.	Mixed W. I. & Steel.....	10 Bldgs.
5.	C. I. Mixed with W. I. or St.	10 Bldgs.
6.	Without data.	2 Bldgs.
		63 Bldgs.

Rating of Cast Iron, Wrought Iron and Steel

If we analyze the records for all systems over 20 years old, as recorded in Table 1, and also in the individual reports, which are too voluminous to be embodied in this report, we find that a total of 33 roof terminal vents were steel, 155 wrought iron, and 218 cast iron. If we now attempt to summarize as far as possible, the condition of all these vents, we find the interesting facts as per the table.

The poorer rating for cast iron in comparison with wrought iron as shown in Table 1, is to some extent due to the probably higher average age of the cast iron installations. The comparison refers only to destruction or near-destruction by corrosion and does not take into account several dozen cast iron vents which had clogged up with rust at the increaser below the roof and thus become temporarily useless. Neither does it take into account the condition of the joints, which would further improve the rating of wrought iron over cast iron. Steel pipe, it will be noted, is so completely destroyed by corrosion after 20 years as to exclude all consideration of joints or clogging which might otherwise be figured in its favor.

Buildings from 10 to 19 Years Old

Returning now to buildings from 10 to 19 years old, Table 1 exhibits a large number of steel installations indicating how completely steel pipe, on account of its slightly lower first cost, has come into use in Chicago. A rating table compiled along the lines just described, but distinguishing between black and galvanized pipe, forms the second part of Table 1.

The 100% perfect condition of cast iron is due to practically all the pipe being extra heavy, and a small depreciation of such pipe could not be attempted in a rough estimate of this kind. With reference to galvanized steel pipe, it appears that galvanizing is partly or wholly destroyed before the pipe is 15 years old, protecting it from destruction to this extent, the pipe as a result lasting from 15 to 25 years before complete destruction is observed. The relatively good condition of wrought iron, both black and galvanized, should again be noted, the 10% given in table indicating a slight depreciation but no actual failures. The figures indicating total number of vents of cast iron and wrought iron in this table are far too low, as on roofs where all the vents appeared to be good only one or a few tests were made on wrought iron and no trouble taken to report on all the cast iron.

TABLE I—RECORDS OF PIPE CORROSION IN CHICAGO BUILDINGS INVESTIGATED

Note—Letter g after iron or steel means galvanized. Letter b means black. Where no letter is appended, it is understood the pipe is black.

Installations over 20 years old.

Pipe	Total number of vents	No. vents entirely or nearly destr'y'd	Estimated percent destruction
Steel	33 Vents	All practically destroyed	90%
W. I.	155 Vents	17 Vents nearly destroyed	20%
C. I.	218 Vents	43 Vents nearly destroyed	25%

Installations 10 to 19 years old.

Pipe	Total number of vents	Present condition Galv. 25 destr'd	Percent destruction black pipe
Steel	104 g 168 b	168 Black all scaling badly	75%
W. I.	8	Both Black and galv. good	10%
C. I.	13	All good	0%

Buildings Less Than 10 Years Old

In perusing the tabulation, one is struck by the fact that the severe corrosion of steel pipe becomes evident even before the building has passed its first decade of existence. Notable examples are the Cook county building, 10 years old, with 34 steel vents about half of them galvanized. Further, the city hall, 7 years old, with 42 steel vents, all galvanized but in spite of this all scaling severely. This does not lend substance to the oft repeated claims concerning the marvelous improvement of steel pipe in recent years. If anything, these new installations seem to be relatively worse than the older ones.

Design of Drainage Systems in Chicago

It is recognized that in downtown Chicago, the main street sewers are too small, a condition which is made worse by the fact that they are elevated but a few feet above the lake and river outlets, giving a very sluggish flow. The street sewers have been found full of water well beyond midnight, when repairs are usually made without difficulty in other cities. Further, the pipe sizes used in vents and wastes in large buildings generally are too small and skimpy, resulting in blowing out of trap seals and in syphonage of fixtures. The conditions noted with respect to sewers long since caused the main house trap to be abandoned, the sewers and house drains being ventilated through the plumbing system. The sewers are also ventilated by means of man-holes in the street. Altogether, there can be no question but what these conditions combine to aggregate the corrosion in pipes in this city, for although corrosion of drainage piping is severe everywhere, it appears to be about 50% worse in Chicago than in New York and other cities. We discovered in the course of the investigation considerable evidence indicating how to improve the service obtained from the pipe system, both in respect to proper functioning of fixtures and pipes, and lessening of corrosive attack.

All Corrosion Internal

If the destruction of the different pipes mentioned was confined to the roof line or the space immediately below it there might be some grounds for believing that sulphuric acid gas from burning coal would be the destructive element. This, however, is not the case, as the corrosion is mainly from inside of the pipes. In the Borland building the soil, waste and vent pipes at the third and fourth levels were entirely rusted away while the same lines of pipe near the roof were practically as good as when installed. In the Unity building a wrought iron waste line from urinals was rusted out entirely from the third floor up. In the Great Northern Hotel building it was found during the process of reconstruction of bathrooms about 10 years ago that the old pipe system of waste and vent pipes was entirely destroyed at the threads and over practically the entire length of the pipe in many places. In other instances drains hanging on the basement ceiling have rusted through and had to be replaced and branch soil and waste pipes on intermediate floors were subject to the same deterioration from internal corrosion. So it is clear that the agency causing corrosion is not from the atmosphere above the roof, but is due to the gases developed within the plumbing system itself and from the sewer in the street.

Height of Vents Above Roof

The general practice in Chicago is to extend the vents about 1 ft. above the roof, while in New York City vents on large buildings are usually from 7 to 12 ft. above the roof. Very few people can furnish a satisfactory explanation of this difference in practice. I think the case of the Standard Trust & Savings Bank building in Chicago explains the reason. In this building trouble was experienced with syphoning of fixtures. It was thought to be caused by the suction of winds sweeping over the roof, preventing the free influx of air to the vent to relieve the vacuum in the wake of water rushing down the pipes. Galvanized sheet-steel extensions about 5 ft. high were therefore fitted to the top of the vents,

with the result that the trouble was completely eliminated. The extension also is to be recommended because it serves to keep the exceedingly strong fumes from being inhaled by workers or occupants of the roofs and pent houses.

Vent Increases at Roof

City ordinances in Chicago demand that the size of vents and soil stacks be increased from a point directly below the roof to the top of the pipe, to prevent hoar frost from closing up the pipe in cold weather. Unfortunately, this causes rust and dirt falling down the pipe to find lodgment at the increaser, clogging up the pipe and defeating the purpose of the ordinance. This tendency to clogging is noticeable everywhere, even in cast and wrought iron pipe installation. The type of fitting now used as an increaser has a more gradual taper than that formerly in vogue, but the tendency to clog can hardly be eliminated. The remedy would seem to be in the adoption of larger sizes of pipes, all the way down through the building, and if increasers are used, they should never be over 1 in. taper. It would seem far preferable to have the hoar frost closing up the pipes for a few days in extremely cold weather than to have the pipes permanently clogged up with rust and dirt.

Proportioning Pipes to Suit Number and Size of Fixtures

In a certain building there were over 40 closets on the 17th floor, besides lavatories and urinals. All these fixtures discharged into a 6 in. stack. During rainy weather, the rain water emptying into the main house sewer, added to the discharge from the 17th floor toilet rooms, would cause trap seals to be blown out and waste water overflowing from fixtures on lower floors and in basements. This trouble was overcome by the installation of an extra relief vent, but it would be far cheaper in all buildings to prevent costly and annoying occurrences of this kind, by employing in the first installation pipe of larger sizes for both soil stack and regulation vent.

Leaky Cast Iron Joints

From the standpoint of sanitation, one leaky pipe is as bad as another, regardless of what causes the leak, be it corrosion or merely the giving way of a joint from expansion and contraction.

Although the tabulation does not make specific mention of the fact, many instances of leaky caulked joints were observed, and unquestionably many also escaped our attention, being more or less inaccessible. Many joints also had been recaulked, but it is nevertheless, a regrettable fact that leaky caulked joints are not always readily discovered, and even less frequently repaired with promptness, in the meantime permitting the escape of gases of a noxious, if not dangerous, character. Unquestionably the screw joint is to be preferred from this standpoint, as long as it can be obtained without sacrifice of the necessary rust resistance of the pipe material.

Steel Pipe

If satisfactory service from black and galvanized steel pipe is only obtained for a relatively brief period of 5 to 15 years, and our ordinances do not differentiate between such pipe and wrought iron, I believe we are not playing fair with the public who pays the bill. The evidence against steel pipe is so indisputable as to admit of no contention. I am firmly convinced from what has been demonstrated in this investigation, that there is a most decided difference between steel and wrought iron for such purposes as are necessary in a sanitary plumbing system, and that we should recognize that fact, and in the writing of ordinances, laws or specifications we should provide that steel pipe be not used in any buildings except those of a temporary character.

Influence of Recent Events on Utility Valuation Procedure

By John W. Alvord, Consulting Engineer, Chicago; Chief Engineer, U. S. Housing Corporation, Washington, D. C.

The Great World War has disarranged or destroyed many a well established conviction of mankind and among other minor matters, it has somewhat jolted the practice adopted among a certain class of routine valuators who consider that past cost is the proper measure of value of a public utility property.

It may well be asked what relation has pre-war cost to present or future value. Evidently little or none. Old things have passed away, requiring us to find our economical adjustment in a new and greatly changed world. The war has indeed contributed a new and most important chapter in its lesson of economics and valuations.

Value is Not Constant

First of all, the war has taught more of us that value is not the constant thing we considered it, for we have seen its level in a state of constant fluctuation, violent at times, and never entirely free from changes.

The war has brought vividly to those engaged in valuation work the important conclusion that value, as a conception to be practically realized, is, after all, a thing always very dependent on what is yet to come. So wound up is it with what is yet to be, so dependent is it on the next stage, that it is no wonder it seems indefinite and elusive. So suddenly has this conviction been forced upon us by the war that numbers of those interested in the subject are either quietly discouraged or openly skeptical as to whether any real principle of valuation is permanent and enduring.

Principles of Valuation Not Destroyed

Now it is not at all true that the principles of valuation have been undermined or destroyed by recent experiences. The misapprehension is due to the fact that there has been too little of the broader grasp of the subject and too little understanding that valuation depends upon human judgment derived from incomplete data and not at all upon a formula or a rule of mathematics. Out of the war we have learned that in valuation work we must consider the future more and the past less. We must admit that to value a property we must become, so to speak, more of a prophet and less of a historian.

When one stops to think of it, a gold mine may have the most wonderful plant, the finest facilities for the removal of ore, a splendid organization and a long past history of rich dividend, but if it reveals signs of early and complete exhaustion, all this past upbuilding goes for naught and all its value drops out when the truth is published.

So, too, with the public utility. Its past record of good earnings is chiefly of interest because it enables us to reason about the future, because it is the probable future usefulness that gives a utility plant present value.

It must be agreed then, I think, that the war has taught us forcibly that value must depend upon a correct prophecy of future conditions, rather than a delving expedition into the dust heaps of things gone by, and those who intently study the probable result of all the forces working for future results will come nearer to determining value than the student of yellow and musty accounts. How many utility valuations of the year 1914 and the years just before are today worth the paper they are written on?

Too many of our Commissions, Courts and appraisal investigators base valuations of utilities on past cost oblivious to all future conditions. Such errors are due to two reasons:

First—Because of a certain timidity toward accepting conclusions drawn from unrecorded data and independent thinking, and,

Second—An unconscious desire for an exact mathematical solution.

Measure of Value

As has been said, value depends upon the ratio of all the immediate and easily available supply to the immediate and reasonable demand or need, but we must fix values in some practical and workable manner that is at once sensible and convincing. Thus, for instance, it is not far afield to say that the value of a public utility plant is measured by the present demand and probable future need of the community for its service. This at least reduces the problem down to something about which we can reason and figure.

For convenience, we commonly measure the probable relation of human need to its supply in terms of money, but this method too often gives our conclusions an appearance of exactness which they are far from possessing.

The constant endeavor also to determine an approximate future value gives rise in common life and ordinary transactions to a sort of give and take method of guessing it out, known as market or exchange value, as distinguished from the real or intrinsic value.

Intrinsic Value

Real or intrinsic value may be described as the theoretically correct balance, usually measured in money, between a human need and its supply. Were it possible, we would always like to know the theoretically correct value even if we did not propose to use it. But it is impossible at any time to know theoretically correct value, because among other reasons, we are human beings and cannot at any given time know all the facts of the present and the future, or correctly and properly analyze them. Therefore, intrinsic value is a thing which we must always seek, knowing that we can only approximate but never fully find it.

Intrinsic values of a utility at some past time can be closely determined because in the meantime the future supply and demands have become known and our foresight has become hindsight, thus eliminating all uncertainties of prophecy.

But the intrinsic value of a thing at some past time is not commonly desired or especially useful in fixing present public utility values. We wish in regulating rates of public utilities to regulate rates of the near future, not of the past, and in purchasing a public utility plant we wish to know the intrinsic value in the near future, rather than in the past, and to know the intrinsic value of a utility plant for the future, we must know how much its service will be needed in the future and if there will be a growing desire for its product by a prosperous community, or a diminishing desire from a declining population.

Limitations of Market Value

One of the fruitful sources of dissatisfaction with utility appraisement proceeds from the fact that proper utility appraisement does not seek the market value. Market value besides being a trade between insufficiently informed purchasers and sellers, always represents the weakness and helpfulness of one or the other, and in so far as it does this, diverges from true or intrinsic value. Large sections of the public accustomed to taking trade advantage of the helpless, cannot understand the necessity for careful investigation and impartial analysis of utility values by an inquiry confined to intrinsic value.

Granted, therefore, that utility plant value depends on the relation of a human need to its supply, that it is the intrinsic or true relation that we seek, and that a large part of this relation admittedly depends upon future tendencies and developments, how shall we proceed and what shall be our tools with which to work in order to produce practical results? Obviously, we only need to begin with the facts of the present and predict the rest so far as we reasonably can.

Limitations of Past Cost Method

Strictly speaking, the actual past cost investment of a utility lacks all the significance unless of recent construction, or unless such past cost investment has been increased by all its appreciations of value and decreased by all its losses.

This latter method theoretically should give us the present reproduction cost less depreciation, and, provided the public needs and their source of supply continue in a state of equilibrium, this theoretically should be equivalent to intrinsic value. value.

But as a practical problem no intelligent being, no matter how expert he may be, can trace out all the appreciations and depreciations of a long life history of a property and correctly determine their influence in terms of money, and add or deduct them, as the case may be, to the original cost and capital account. It is too gigantic a problem for the human mind in the first place, and the data are almost never available in the second place, even if the human ability to make proper use of it were to be found.

Such influences as increasing human needs, human endeavor, as reflected by the management, fortunate attitude of the public, or growth in community enterprise are constantly adding value to utilities, while wear and tear, changes in the art, alterations in custom of the public are examples of forces certain to result in losses.

In valuation work most studies of past cost do not attempt to bring the investigation beyond a year by year statement of cash expenditures, and as such, it is incomplete.

Method of Reproduction New Recommended

Now, we can avoid much of the dilemma occasioned by trying to reduce past cost down to present and future value, by using the method of reproduction new, or cost new as of today. This is not a simple or easy method for those inexperienced in actual construction, but the great advantage of estimating cost new as of today lies in the fact that it is unnecessary to deal with all the subtle influences that have been added to or have been lost from the past cash investment, the record of which is to difficult to obtain or to interpret.

Reproduction new, as of today, deals with present information easily obtainable and readily verified. It places us at once in the position of expending our time to good advantage upon present conditions and leaving us some time and opportunity for analyzing the future influences, whose consideration are so important.

Mistakes in Applying the Reproduction Method

Reproduction new as of today is a method which has some fundamental principles, the most important of which is that, while purely a mental process, it must be conceived and followed through in a manner which is humanly possible, or else the measure which it is supposed to give is false and misleading. Unless the appraiser himself has lived through and experienced not one but many actual constructions of a similar kind, he will be misled by the ease with which his imagination can overcome obstacles and perform prodigies. To minds unexperienced in construction, the reproduction method becomes a magic wand waved over the property to be appraised, with the result that it is immediately and astonishingly recreated without any difficulties or embarrassments, such as are encountered in dealing with human nature and overcoming the ordinary obstacles in the building world.

The commonest mistake is to forget that time or preparation are necessary to rebuild a property. To the novice it suddenly exists. This marvelous result is accomplished by a multiplication table, a price list and a hasty inventory.

It has also been solemnly proposed to price present property at past unit costs as a fair basis for utility rates, as though such a combination could actually exist in real life, or were at all useful. Imagine the possibility of creating ships today at pre-war prices! That truly would be magic.

Wise gentlemen have seriously proposed to begin the reproduction process several years in the past, so that the imagi-

nary utility plant would be finished at the date of valuation of today.

Some estimators, in a sort of distrust of reproduction methods, prefer to discover what past cash cost of a property has been in the year by year method and then make a reproduction cost estimate to correspond with the total. Past cost thus found is sort of an assertion that past cost may not scientifically control, but is, nevertheless, right.

One of the most hotly supported fallacies has been that the physical property of the plant may be reproduced, but the financial transactions, business and income reproduction, must be omitted. This is the famous "Going Value" controversy, which will long continue to receive distrustful protests from the adherents of magic reproduction.

Proper Use of Reproduction Method

Reproduction cost new as of today, if it is not to be worse than useless or even positively deceptive, must be thought out in every detail, as if a real plant was being constructed; it must be initiated at the date of valuation, as would only be humanly possible, and progress thenceforward over reasonable periods of time. It should be financed, planned, projected and constructed without magic, without omission of difficulties, without impossible speed, and without startling freedom from human vicissitudes, natural obstacles and ordinary delays, and finally, it should be carried to completion not only as to its physical property, but as to all of its financial relations and income.

Because the existing plant to be valued usually is not new, and the reproduced financial effigy of it is new, the latter must be reduced by the amount of depreciation that the existing plant has undergone to make the reproduction correspond to an old plant rather than a new one.

When all this work is conscientiously and fairly done and done by mature and intelligent valuators, we have a useful beginning, a stepping-stone or yardstick with which to consider present and future value.

For reproduction when completed is not necessarily value. Value, as I have before stated, is dependent upon future usefulness as well as present efficiency. I have before cited the gold mine with its splendid plant and organization which has no further ore in sight. Evidently reproduction there is not value. Far from it. Something more than a reproduction method or yardstick is necessary. Future conditions and probabilities must be examined before we are at liberty to come to final conclusions.

Considerations Affecting Future Value

To successfully prophesy the effect of the future on any property, we should examine the tendencies which in the near future may or may not make it stable and permanent. Some of these considerations are:

First—Is the community prosperous and growing? Is the service needed and will it continue to be increasingly needed?

Second—Is the plant well designed and well fitted for its work; can it be easily enlarged and is its location permanent?

Third—Has it been properly and economically financed and operated?

Fourth—Is the service reasonable to the consumer; that is, really worth as much or more than he pays for it, and will this condition continue? In other words, will the service continue to be reasonable?

Intrinsic Value Sought, Not Market Value or Past Cost

Carefully analyzed in connection with the past history, the reproduction cost, the normal or abnormal condition of prices at the time of estimating reproduction, these data are before the appraiser's mental court of inquiry for a final conclusion. Such conclusion should be as nearly as possible the intrinsic value of the property in the near future and not the market value of the present, or the summation of the past investment.

What sound valuations should accomplish is to create and maintain good service by the utility at reasonable rates, that is, at rates so productive that there is an incentive to keep adding capital to the enterprise, and at the same time so just that the consumers can obtain no better service elsewhere for the same money. If these conditions do not obtain at the present and cannot obtain in the near future, then that particular utility cannot profitably exist.

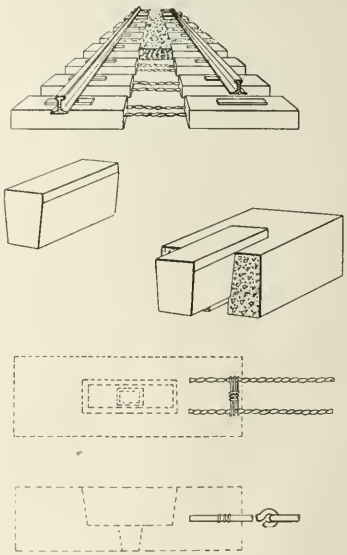
The foregoing discussion is the major portion of an address by Mr. Alvord before the Public Utility Section of the American Bar Association.

A New Concrete Railroad Tie

The practicability of the reinforced concrete tie here illustrated has been demonstrated. It has been tried in severe service for a number of years and has stood the test of wear and time. The tie is here illustrated in service on the municipal railway of the city of San Francisco. Two years after these ties were placed in service, City Engineer M. M. O'Shaughnessy wrote of them: "They have been found satisfactory in every respect and have required no attention since installed. In fact, I think that we can forget about these concrete ties until the rails are worn out, and when the rail is renewed the only thing that will be required will be to renew the wooden blocks to which the rail is spiked."

The tie consists essentially of two reinforced concrete end sections connected by two ¾-in. steel rods extending into and almost through the end blocks. This leaves an open center and eliminates at once the danger section of the continuous concrete tie by simply omitting it. This open center construction also eliminates creeping, as one-third of the road bed remains intact.

Each of the reinforced concrete end-sections has a slot recess, slightly tapering downward to a distance of about two-thirds the depth of the tie. Into this recess a block of wood is pressed, with about an inch protruding above the surface of the concrete, to which the tie is spiked. The rail is spiked down with the ordinary spike, in the ordinary way, by the ordinary labor. The depth of the wood block is more than sufficient to take the spike. This wood block has the advantage of a wood tie in resiliency and dissipation of vibration. The wood is supported on sides and bottom and can not



DESIGN DETAILS OF NEW OPEN-CENTER CONCRETE RAILROAD TIE.

crack, thus increasing the efficiency of the spike. There is reinforcing in the concrete around the wood block to prevent splitting. A hole running from the base of the recess in the tie to the bottom of the tie provides means for inserting a tool to drive out the wood block when it is necessary to replace it. In general practice the wood insert is made of two pieces, slightly tapering, which makes them more efficient when inserted, and yet makes them easier of removal when necessary. These ties are made the same depth as the standard wood ties, and can be interchangeably used with wood ties, so that the action of frost is exactly the same even if they alternate with wood ties. With this tie a tie-plate may be used but the tendency of the impact to compress the block instead of disintegrating it, largely obviates the necessity of tie-plates.

The wood blocks may be of hardwood, or they may be treated. A method of treatment of the twisted steel joining rods may be used to make their life longer than the life of the concrete tie itself. These ties were invented by E. N. Goodlett, Marquette Bldg., Chicago.

VIEWS OF OPEN CENTER REINFORCED CONCRETE TIES ON MUNICIPAL RAILWAY, SAN FRANCISCO. BEFORE AND AFTER PLACING BALLAST.

How to Prevent Freezing of Riser Pipes to Elevated Water Supply Tanks

Frost casings which are now almost universally used and which are designed and approved by fire insurance writers and consulting engineers, are only a partial protection, says the Chicago Bridge and Iron Works organ, "The Water Tower." The following preventive measures are recommended:

The freezing of riser pipes during extremely cold weather can be prevented by four means, as follows:

1. Providing method for artificially heating the water in the riser pipe.

2. Conserving the heat in the water by providing sufficient insulation to prevent loss of heat.

3. Maintaining the temperature of the water above freezing point by pumping and withdrawal of the water.

4. Adding certain chemicals which will lower freezing point.

Sprinkler Tanks

Sprinkler tanks in which there is practically no circulation, require frost casing and in addition, means of supplying artificial heat. This can be done by either—

(a) A steam coil in the bottom of the tank with the steam supply and return pipes running inside of the frost casing and next to the riser pipe.

(b) A system of hot water circulation applied at the base of the riser either by means of hot water heater, which may be fired with gas, oil, or coal, or by a special heater in which steam is the primary source of heat. In this type of heater cold water is taken out at the base of the riser, passed through the heater and put into the tank through a 2-in. pipe.

(c) When conditions prevent either of the above methods being employed, it is possible to inject live steam into the tank, thus keeping the water in the tank and riser warm.

Where there is only occasional service from the tank, and therefore, intermittent circulation, a more or less elaborate frost casing may be used to prevent freezing. In such cases, however, a special design using a large cylinder in place of the riser pipe is best. This cylinder can be built in any length and size, varying from 4 ft. in diameter in moderate climates, to 6 ft. in diameter, in rather extreme climates. In cold weather ice will form on the inside of the cylinder and serve as insulation, very efficiently retarding the further loss of heat. Under normal conditions a 6-ft. riser pipe should give satisfactory results in any part of the United States.

Municipal Tanks

In tanks for municipalities, artificial heat is rarely applied and the ordinary type of frost casing is depended upon to prevent freezing. This is usually satisfactory, because there is almost constant circulation in the riser. The most frequent practice is to operate pumps during the day to take care of the requirements of the town and also to have the tank filled by evening. At night the pumps are not operated and such water as may be consumed by the town is drawn from the tank. Pipes through which the water circulates from the pump house to the tank, are laid well below the frost line in the warm earth, and the water in passing, even if it is drawn from a cold reservoir or river, is usually warmed well above the freezing point by the time it reaches the tank riser. If the water is drawn from a well, the temperature will seldom be found to be below 50 degrees Fahrenheit. The tank is, therefore, filled with the water well above the freezing point and there being almost constant circulation in the riser, there is little danger of freezing.

Precautions in Special Cases

When a municipal water works system is placed in service, there is usually very little consumption and, therefore, very little circulation in the riser. In such cases care should be taken to draw off and pump a reasonable amount of water each day, so as to provide artificial circulation. This can perhaps best be done by opening fire plugs in the morning and drawing the water well down and refilling the tank during the day.

In occasional water system installations such precautions

are not taken, with the result that during the extremely cold weather riser pipes freeze and the city is called upon to bear an expense which could be prevented with a little care.

The same condition is liable to arise on tanks which are furnished for private estates, farms or for other purposes where the water is only used intermittently. Either artificial heat must be provided or more or less rapid circulation be maintained by alternate drawing off and refilling the tank. This condition is usually exaggerated on small tanks because the service pipes are small.

Superintendents of water works for municipalities and engineers of industrial establishments, should take particular care to see that there is circulation at all times in the riser pipe of tanks during cold spells of the coming winter. Should you be so unfortunate as to have the riser of your tank freeze up, you should take prompt action to thaw it out, for by so doing you may prevent your pipe from bursting.

Thawing Out

In case of a freeze-up we have found the following method to be the most satisfactory in thawing out: Make a 1-in. tap in the foot elbow, and another one in the riser pipe about 4 ft. above the first opening, then connect a steam line from an ordinary boiler into the top hole, turn on the steam "not over 100 lbs. pressure per square inch" and in a short time water will begin to drain out of the hole in the foot elbow; leave the steam turned on until the water in the tank begins to run out.

All of these points apply equally well to any other kind of a tank with a small riser pipe, instead of a large cylinder.

Snow Removal on Trunk Line Highways

By Charles J. Bennett, State Highway Commissioner of Connecticut, Hartford, Conn.

We have arrived at the period when it is necessary to consider the removal of snow from highways of great length in order that the traffic which has developed may be accommodated. Two things are evident: First, that the snow must be removed. Second, that it must be removed by the agency responsible for the condition of the highways, said Mr. Bennett, in addressing the Highway Traffic Association of the State of New York.

Continuous Service Demanded

In consideration of the first idea, we know that the traffic has developed to such a point as to demand continuous service on main traveled motor routes for twelve months in the year. This fact cannot be evaded. The motor is here; it has its place in our national life and in order that it may give us efficient and maximum service such service must be continuous. The establishment of rural routes, the utilization of trucks and passenger motors command the attention of highway engineers and the snow removal problem becomes a vital issue to be solved at once and successfully. This is not a war problem but an activity that has come to stay.

Requires State Supervision

On the second statement, namely that the state highway departments must perform the work, it must be admitted that the work will never be properly done if left to the ordinary county or town agencies. The results would be of different standards and in many cases reached tardily or not at all. Then, too, the fees for motor licenses are almost invariably turned over to the various highway departments for highway maintenance and as inferred above this work is recognized as a vital part of our maintenance problem. Add to this the fact that intelligent snow removal results in a decrease in cost of repairs in the spring and we may write Q. E. D. after our two propositions.

Fundamental Principles

A study of the subject reveals several fundamental principles which should be recognized:

First, that different sections of the country require different methods and degrees of snow removal.

Second, that the methods devised should take into consideration the character of traffic and the number of vehicles of different classes to be accommodated.

Third, that the methods to be devised will depend entirely on the degree of removal required. For example, in the northern states where heavy snowfalls occur, it is not necessary to consider at the present time any system of snow removal which will allow the passage of trucks, because there are few trucks which need to be operated in these sections. The amount of snow to be removed is so great as to make the cost of the work prohibitive.

On the other hand, in the Atlantic tier of states where at times the snowfall is heavy, it becomes necessary to remove

VIEWS SHOWING REMOVAL OF SNOW FROM CONNECTICUT TRUNK LINE HIGHWAYS.

Upper Views Show Tractor in Use with Road Machine—Lower View Shows Motor Truck with Snow Plow in Motion.

the snow so as to allow the passage of motor trucks, because these trucks are numerous and important to commercial activities. The universal use of other motor vehicles for business or pleasure purposes demands the removal of snow so that people may go about their ordinary pursuits by motor, even in the winter time.

The method for breaking out highways or for the removal of snow will depend, as noted above, on the character of traffic to be accommodated. Again, certain fundamentals should be taken into consideration in devising a system of snow removal.

The problem of the trunk highway differs from the problem of the city street, since the area to be organized is so large that no one person can comprehend the amount and character

of the work to be done or personally supervise the removal on any given snowfall. Evidently, snow can be more easily disposed on country roads than in the city streets.

Plan Prepared in Advance

Owing also to the necessity for promptness of action, a system must be devised which will go into effect immediately upon the appearance of snow, and result in the prompt removal of the necessary amount of snow, such removal to be completed within a reasonably short time after the storm and to such a degree as will permit of the passage of the preponderant class of traffic. The necessary equipment for the purpose must be provided and located at convenient points so that it can go into prompt action; in many cases, without notice from headquarters.

Unnecessary work may often be done, but it must be recognized that this work is emergency work and the benefits in many cases are negative.

During certain storms the telephone system is either seriously hampered or entirely put out of commission. Consequently, a system of snow removal to be effective should be independent of the telephone, and the men having the operations in charge should be drilled in their duties sufficiently in advance so that they will know what is to be done and proceed with the work without delay on the arrival of a snowfall which is in excess of 3 ins.

Long Hours Requisite

The hours of labor should not be restricted, and the time of starting should be early enough so that the forces can get the best of the storm and always keep slightly ahead of it. For instance, it has been my experience in several cases where the department has not taken prompt steps to remove the snow as it fell that traffic was seriously hindered on account of this delay, and in some instances the satisfactory removal was deferred for several days after the occurrence of the storm.

Organization

The organization for this work should be elastic; the foremen or supervisors having the work in charge should have a free hand to employ the necessary men and teams to take care of an abnormal snowfall. A definite district should be allotted to each foreman or sub-foreman so that too much work will not rest upon one man. It is remarkable to note what an immense amount of work can be done with snow for a small amount of money, providing the work is undertaken promptly and under a systematic plan. Arrangements should be made so that the employes detailed for this work will report at headquarters as soon as a snow storm commences and remain on duty until the work is done or is shown to be unnecessary.

Using Road Machinery for Snow Removal

One of the difficulties in removing snow is that the special equipment is in many instances not suitable for other purposes, so that an endeavor should be made to adapt the ordinary roadmaking or maintaining machinery for the purpose of snow removal. This has been done successfully in many instances, particularly in the devising of scrapers or plows to be fixed to the front of motor trucks for the purpose of removing snow from highway surfaces. These trucks are successfully operated in cases where the wheels can secure a firm grip on the road surface, but are not satisfactory in operation where the snow is allowed to drift or to accumulate to a depth in excess of 6 ins., which is again an argument for promptness of action. Work should start on a continuing storm when the snow is 3 ins. in depth.

Road machines may be used either drawn by horses or attached to the rear of a truck and hauled through the snow. The difficulty with road machines is the same as in the case of motor trucks—the wheels must have a bearing on the road surface in order to allow the work to be done successfully. As a matter of fact, much of the snow removal work must be done and is done using draft animals and makeshift apparatus. This applies especially to those highways where drifted snow is to be removed in order that wheel traffic may be accommodated, the first operation consisting in running a team or several teams attached to a bob-sleigh over the road. Attached to this bob-sleigh should be some form of plow which will break out the snow on the surface of the road and allow a more efficient type of machine to be handled by motor truck or tractor.

Use of Snow Rollers

In cases of highways where it is necessary to provide for the passage of horse drawn vehicles on runners, the use of snow rollers is advisable. These snow rollers consist of heavy wooden rollers drawn by horses or oxen. The rollers compact the snow so that the travel can pass over the top. There is no practical use for this method where trucks are to be used.

The main problem before the maintenance engineers of today is, however, the removal of snow on highways to accommodate truck traffic, and the points mentioned above should be re-emphasized; namely, promptness of action to a specified plan which should go into effect without notice if the telephone fails; lack of attention on the part of the help to hours of labor or the time of day when the work is to be done, and continued service until the trouble has passed.

Cost

As to cost—in connection with an unusual winter, the total cost of snow removal for 1917-18 was approximately $50,000 for 1,000 miles of highway cleared with varying degrees of excellence and of varying depths of snow. In general, for work of this character in this section of the country, an estimate of $45 per mile per year should be made where two lines of truck traffic are to be accommodated and the snow removed promptly.

In this work advantage should be taken of the weather bureau. My experience has been that these reports are of value though at times they miss local storms and in some instances fail to predict serious snowfalls. We are all relieved when a prediction of snow results in rain or in no precipitation. In general, this bureau is an aid but not an entire reliance.

In conclusion, when all plans are made, the chief officer of the organization should watch the weather and be sure that all his assistants are alert and on the job. As a result of some years of experience in city and state work, I can say that snow removal work is the cause of much criticism and results in many disheartening failures. Here, above all, we have to admit that "eternal vigilance is the price of safety."

And after the snow is removed and traffic is accommodated, look out for the waterways.

County Commissioners Replace Wooden Flume Across Roadway with Double Iron Siphon

The two siphons shown in the accompanying half-tone were installed by the Jefferson County Commissioners of Golden, Colorado. The installation is about seven miles from Denver.

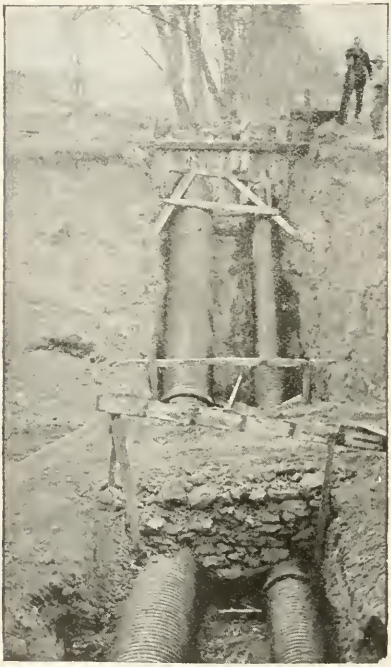
The diameter of the larger siphon is 36 ins. and that of the smaller siphon is 24 ins. The 36-in. siphon is made of No. 14 gauge galvanized and dipped Armco American Ingot iron. The 24-in. siphon is a No. 16 gauge pipe of the same material.

The pipe was made up in lengths of 20 ft. and each length was provided with cast iron flanges, bolts and gaskets for making field connections. Provisions were made on each line for draining as well as for blowing out the siphons in case there would be a tendency for them to fill up with sand or silt. However, it is not necessary to drain corrugated siphons to keep them from bursting under freezing tempera-

tures as the corrugations take care of the contraction and expansion stresses thus preventing the pipe from bursting.

The siphon lines carry irrigation water from two parallel ditches under a roadway and discharge the water into two separate ditches across the road.

These two siphons replaced an old wooden flume construction across the roadway. The old wooden flume was constantly leaking, making the roads almost impassable at certain times. At the same time the old wooden flume structure did not give sufficient clearance for loads of hay to pass under.



SIPHONS OF ARMCO IRON CORRUGATED PIPE INSTALLED TO REPLACE WOODEN FLUME CARRYING IRRIGATION WATER ACROSS HIGHWAY.

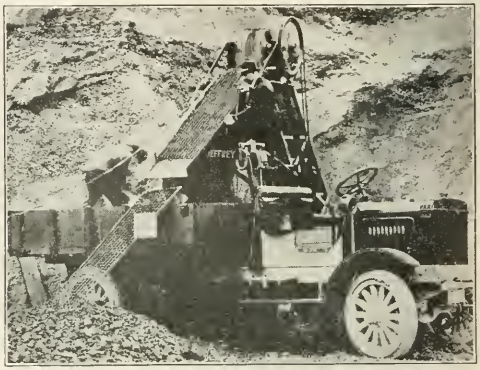
The siphons operate under a static head of about 10 ft. These siphons have been in continual operation for the past three years and have given excellent service and satisfaction and have made a good roadway where at one time the roads were almost impassable, due to the leaking of the old wooden flume.

A Self-Propelling Loader for Loose Materials

The Jeffrey self-propelling loader, although designed primarily for loading loose materials from ground storage into motor trucks or wagons, has proved effective in loading sand and gravel direct from the bank into the truck. The accompanying photograph, of a Jeffrey loader, gasoline-driven, and a Service motor truck in a sand and gravel pit at Milwaukee, Wis., tells the story.

The portability of the machine enables it to work along the bank wherever desired, and the motor trucks, of course, can go wherever the loader goes. Bank-run material can be loaded at the rate of a 5-ton truck every 6 minutes. This would be a 20-minute job for 5 men with shovels.

When a specific size of gravel is desired this can be obtained (note illustration) by passing the material over inclined screens of different sizes that are interchangeable and can be changed very easily and quickly. The screened material falls into the truck and the remainder beside it. The over-size material can be utilized later and loaded by shifting the machine. Some trimming of the loads is necessary.



LOADING GRAVEL DIRECT FROM BANK TO SERVICE MOTOR TRUCK WITH JEFFREY LOADER.

One laborer operates the loader. He can advance the machine under its own power into the bank, then back up and move to any other position along the bank. The digging elevator can be collapsed for convenience in moving the machine a long distance. This loader is manufactured by the Jeffrey Mfg. Co., Columbus, Ohio.

Organization, Methods and Equipment Employed in Removing Snow from Main Roads in Pennsylvania

By George H. Biles, Second Deputy State Highway Commissioner, Harrisburg, Pa.

Pennsylvania has a keen appreciation of the volume and character of present day highway traffic and its demands, due to the state's important industrial position. We feel that new methods, increased energy and study must be applied to meet the new highway traffic conditions, said Mr. Biles, in addressing the Highway Traffic Association of New York.

The Test of Last Winter

Our state was put to the crucial test last winter in answering the call of the nation to keep the roads open. I dare say that few of us recall a more severe winter and it augurs well for the future when such abnormal conditions can be successfully combated as was the case with our main arteries of traffic last winter.

The first steps taken to cope with the situation were to provide an organization to prosecute the task efficiently. This was but an enlargement of the regular force of maintenance employes. We have a colossal maintenance proposition in Pennsylvania in looking after the upkeep of over 10,000 miles of highways, approximately 65% of which are unimproved, and with a working force in some periods of the season of over 12,000 men, it must be granted modern business principles in organization and operation are essential.

Organization for Snow Removal

The Division of Maintenance of the Department composed of the assistant engineers, superintendents, foremen, caretakers, labor, etc., took complete charge of the snow removal work under the direct supervision of the second deputy commissioner. From the inception of this division in 1913, surveys and studies have been made of snow conditions and data compiled that has and will continue to serve in good stead, for there are many points where it has been developed that

the construction of snow fence is the most economic practice.

Snow Fence

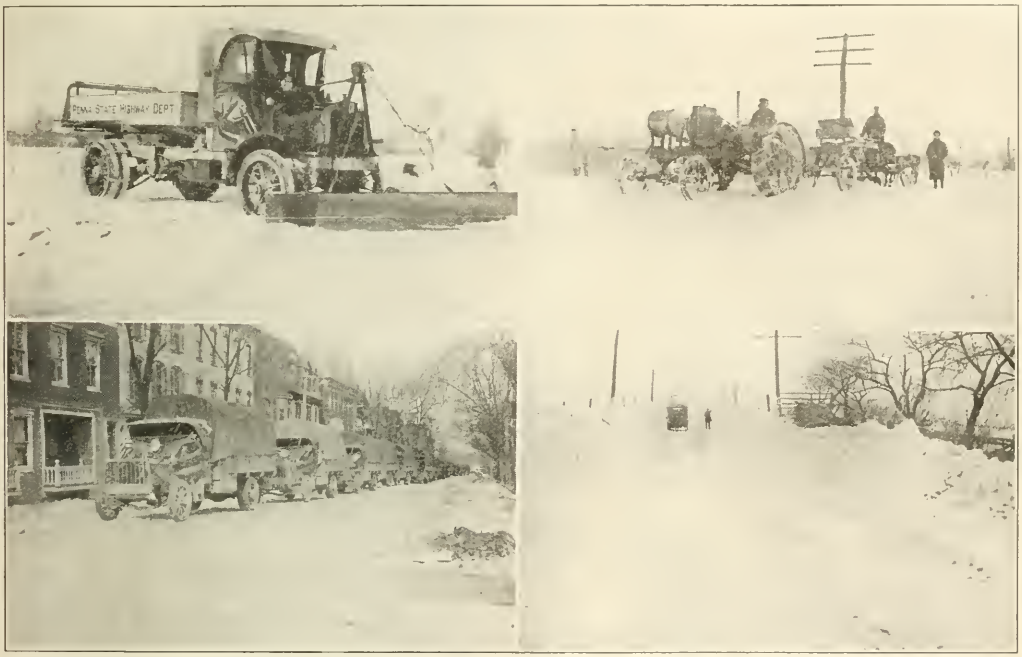
Considerable of this snow fence has been constructed up to the present time and is ready to be put in place. At present prices this costs approximately 50c per running foot in place and the design closely approximates the railroad standards.

Due to the war conditions, a new class of traffic had to be reckoned with in the United States Motor Convoys, the imperative nature of which justified some of the unusual measures taken. As an example, arrangements were made with the Weather Bureau officials to wire forecasts of approaching storms to the central office at Harrisburg, which information was communicated immediately to the local forces. This affords an opportunity to anticipate conditions and organize accordingly. The War Department also wired proposed convoy movements, whose schedule was followed closely from the time they reached the western limits of the state until they passed ont toward the seaboard.

Equipment

Stations were established along the lines of the highways at the larger towns where motor truck equipment with snow plow attachments, road machines, drags, shovels, etc., were located. The caretakers or patrolmen, who were regularly employed on the road, were used as a nucleus to create the forces to handle the work. Systems of reporting were devised through telephone, telegraph and mail, depending upon the conditions, to convey to the central office the exact status of the work at all times. This information upon receipt, was charted and made available at once, from which a bulletin was prepared.

It would appear that what is possible of accomplishment in Pennsylvania in this respect is true of most states, for the topographical conditions are such that energy and resourcefulness were taxed to the utmost in overcoming the elements. When one takes into consideration that a major portion of our state is mountainous and many sections are in altitudes of between two and three thousand feet, in which there are stretches of highways many miles in length where there is not a sign of a habitation for refuge or shelter, being entirely at the mercy of the winter elements, it seems more providential and miraculous, than due to the work of man, that such abnormal conditions were so successfully overcome and traffic maintained. Aside from the dearth of labor that was felt over the whole country at this time, there were sections wherein it was impossible to get labor of any character and the mountains and villages for miles around had to be scoured for hands, who were transported by sleighs to the site of the work. To these hardy mountaineers and men who were prompted by patriotic motives, great credit is due for the success of the work.



SNOW REMOVAL SCENES ON MAIN HIGHWAYS OF PENNSYLVANIA.

White Truck with Snow Plow Attachment—Gasoline Tractor Pulling Road Machine in Removing Snow—One of the U. S. Motor Convoys That Made Snow Removal Imperative—Snow Bound Highway Opened to Traffic.

Snow Fighting

Snow removal work from the experience of the writer resolves itself into snow fighting from the time the first snow makes its appearance. Work begins when heavy falls come by breaking through a track with road drags or small V-shaped plows drawn by teams. These are followed by the road machines or motor trucks with the snow plow attachments. Turnouts are made at convenient intervals and as soon as possible thereafter the road opened to the desired width of from 14 to 18 ft., depending upon the traffic. On improved roads every effort is made to remove the snow within a few inches of the metal of the road, in order that no opportunity is given the traffic to track. What snow remains that does not melt, is removed entirely.

Prevention of Tracking on Improved Roads

I will qualify remarks just made by saying that these methods apply particularly to improved roads, for if traffic is

permitted to track during periods of freezing and thawing on such highways, the surface becomes affected to various degrees, depending on the type of the road. We have a number of miles of waterbound macadam roads with bituminous surface treatments on the main trunk lines, and in order to preserve them during such periods it is essential to distribute the traffic. On the unimproved roads the snow is not taken off entirely down to the surface, but several inches is allowed to remain for the travel to pack, and as it softens more snow is dragged from the sides, in order to keep the surface comparatively smooth at all times.

Rolling Snow

Rolling of snow is done on the lesser important lines, but this has not been very satisfactory on the roads where there is much motor traffic, on account of the rough condition that results when the surface becomes cut up. The snow being rolled and wet from time to time with sleet and rainstorms, becomes almost as hard as ice. However, there are a number of roads where the travel is light and used mostly by horse-drawn vehicles, where this method will suffice.

Attention to Drainage

In the work just described, especial attention was given to the drainage and cuts were made through the banks of snow to the ditch lines at certain intervals where possible, and drains and culverts kept open and free from obstruction. This precautionary measure produced very good results, for when the snow passed away in the spring, the roads had come through the winter in better shape than they had any previous time, in spite of the fact that they have been subjected to greater traffic and increased weight of loads.

Use of Road Machinery and Motor Trucks with Plow Attachments

The heavy drifted condition required especial treatment. Drifts were so deep and banks so high on either side of the road in some places that snow had to be shoveled and hauled out. Snows up to 12 ins. in depth can be handled advantageously with road machines and from 12 to 36 ins., if not too heavy, can be moved with motor trucks with plow attachments, with excellent results.

The truck is run along one side of the highway and back on the opposite side at the rate of about four miles per hour and carries a small crew of men with shovels that are used when the snow piles up in front of the blade, which it will do especially when the snow is wet.

Tractor Drawn Plow

When there is a greater depth than 3 ft., a large A-shaped plow is used. This implement is 30 ins. high at the nose and 6 ft. at the back with 20 ft. legs and 16 ft. wide at the back, held together with movable braces and drawn by a heavy tractor, and it has proven a very economical and effective device. The movable braces are provided for the purpose of permitting vehicles to pass during the operation, if this is necessary. The light tractors for this work do not hold the road and have been found unsatisfactory. Mechanical devices are preferable in the majority of cases but if the drifting is a continuous performance in cuts, it resolves itself into a shoveling proposition.

To keep the roads open under conditions similar to last winter, it costs from $50 to $200 per mile, depending upon the location and other conditions.

Development of Snow Removal in Pennsylvania

In 1912, when our system of roads was taken over for maintenance, the highway laws, with respect to keeping up the road, were not generally interpreted to mean that snow should be removed for it was an uncommon thing for the local road officials prior to this time to open the drifts. In many places, the fences along the line of the highways were removed and the fields used until the snow passed away. If the thaws caused the fields to become soft, the traffic would do them considerable injury. In such cases some effort was made to make the roadway passable. This era quickly passed and with the changing and increased traffic, the demands became great for an open highway the year around, and in 1913 this responsibility was assumed by the State Highway Department and practically all the main trunk lines were kept open from this time on. The records for the winter of 1917-18, which covered the period from December to March, show 22 snow storms varying in depth up to 16 ins., with drifts ranging from 3 ft. to 16 ft. in depth, the general average being 4 to 6 ft.

I firmly believe that where statutes permit, and if they do not the legislative bodies should pass enabling measures at once, snow removal should be no longer an optional matter with the road officials in charge of our highways, for when we consider the enormous winter traffic on some of our roads argument that snow should be removed is unnecessary. As an example, we had a case on one of our highways when the temperature was down to 25 degrees below zero, and actual traffic census showed that over two thousand vehicles passed over the road in 12 hours. Snow removal no longer has only a theoretical existence; it is a practical problem.

The Road: Its Paramount Importance as Viewed by a Briton

By the Right Hon. Sir J. H. A. MacDonald, K. C. B., LL. D., Writing in Chamber's Journal, London, England.

The nations of Europe are now, to the number of seven, ending a war such as has never been seen in the history of the world. The number of the troops engaged and the extent of front occupied by the contending forces exceed anything that has been witnessed in ancient or modern days. For the first time war-transit by road is being conducted to a very great degree by mechanical power, and such power is being used not only for conveyance of stores, but also for moving artillery and machine-guns, serving generals and their staffs by carrying them rapidly throughout the extent of their command, conveying orders and dispatches, and making rapid reconnoitering attacks by armored vehicles, in all of which services great speed can be used without failure or serious limitation of endurance, such as necessarily attaches to a service in which no other accessory power is available except that of animals.

Lessons of the War

This war will, therefore, teach many lessons on the subject of the road. For warfare on any extended scale roads are essential, and more so than ever in the twentieth century. Upon the sufficiency of the roads, and their ability to withstand the attack of heavy traffic without becoming unfit for efficient use, the success of a campaign may in great measure depend. We know how nearly the bad state of the roads jeopardized the arrival of Blucher in time to clinch matters at Waterloo, the whole of a long day being necessary for an 11 miles' march. It is told of the great Duke of Wellington, when a debate took place on the first Kaffir war in Africa, that he summed up what was necessary, in addition to well trained and well armed troops, by saying, "What we want, my lords, is roads, roads, roads!" To his mind roads were essential to the conduct of war, so that the troops and their arms might be used to the best advantage. More than ever today, when power vehicles will be employed in all but cavalry work, it is indispensably necessary that national attention should be freely given to the road problem, so that our country should not be put to disadvantage, if war comes within its borders, because its roads are insufficient in number and deficient in quality.

Change in Traffic.

It may now be laid down without risk of intelligent contra-

diction that if the country is to be well served by its roads, these must be capable of carrying a very different traffic, both in bulk and character, from that of the latter half of the last century, when the use of the road was comparatively trifling, because all distance locomotion by heavy vehicles had been diverted from the road to the railway. In consequence of this old roads deteriorated, and were repaired on the cheap, and new roads were flimsily constructed.

It is now practically admitted on all hands that road construction and maintenance, neglected for half a century, are once more of paramount importance, and that it is a matter of public necessity that the roads shall be made fit to bear the traffic which passes over them, traffic which tends every day to increase in volume as regards all classes of vehicles, and in mileage as regards the distance per day which each vehicle accomplishes. The carriage which used to jog along for its 15 or 20 miles is now replaced by the car, which can traverse three or four times that distance in the same time and be still fit for further work. The professional man who traveled daily by train to and from business now runs in and out in the same time, or even more quickly, by car or motorcycle. The farmer who sent his crops, his fruit, and his vegetables over long distances to the market town can now have them conveyed direct from farm to market more quickly and in better condition, and with less injury, than when loaded and unloaded six times, and knocked about in shunting from and to sidings. The vans of the town tradesman which went 10 or 12 miles into the country daily to deliver goods, now go twice or even three times that distance, out and in, each day. The road tourist thinks nothing of a journey of 150 or 200 miles in one day. All this development has taken place in little more than a decade, and that there will be a great increase of all classes of road traffic for some time nobody can doubt; while in war on land efficient roads will be a *sine qua non*, in view of the strain of heavy traffic of guns and munitions of war. War is no longer a leisurely conducted affair; Von Clausewitz's caustic saying, that "standing still and doing nothing is quite plainly the normal condition of an army in the midst of war, acting the exception," is no longer a true reproach to those who conduct campaigns. Speed is the aim, and the measure of speed is the quality of the road.

The road being now of paramount national interest, a step was taken in furtherance of that interest when the Imperial Road Board was appointed a few years ago, to which was committed the proceeds of the petrol-tax and the auto-vehicle licenses, bringing in more than a million sterling at first, and the amount steadily increasing from year to year.

Increase in Use of Power Vehicles.

Everywhere throughout the land more power vehicles are being put upon the road in each season, and a corresponding dimunition of animal-drawn traffic is taking place. The extent to which this is so appears not to be fully appreciated by many. It is still quite common to hear motor traffic spoken of as something exceptional, and as an intrusion upon general traffic. The power vehicle is still looked upon by many of the public and by not a few local road authorities, as an interloper to which no consideration need be given except by way of complaint and objurgation. People who think so and speak so will have to awake, whether they like it or not, to the fact that motor traffic has in great degree become, and will in greater degree become, the traffic of the road, and that animal haulage must recede into the position of being the exception, and that a negligible exception, where formerly it was the rule.

Traffic Statistics.

A few statistics will be found convincing by all but those who fall into the category of the man persuaded against his will, who is "of the same opinion still." The figures may be interesting. Observations recently made in London bring out most remarkable results. A test recently taken at the top of Haymarket, where the vehicles must pass in both directions through a driving space of only 46 ft. in width, the time of the test being one hour, between 7:30 p. m. and 8:30 p. m., brought out the following result:

PASSENGER VEHICLES.

Motor.	Horse.
1750	17

In country districts it is much the same. Five days' observation in Perthshire gave this result:

Motor.	Horse.
111	1

A test taken of cabs only, in Pall Mall, counting up to 600 of those mechanically driven, resulted thus:

CABS.

Motor.	Horse.
600	4

Of the horse cabs, two were four-wheelers and two were hansoms.

Commercial Vehicles

In the case of the commercial vehicle, the progress has not been so rapid. It was not to be expected that it would be in the same ratio. The merchant using animal haulage has to think twice and thrice before making the change. It is hazardous for him to experiment, as it is the rich only who use vehicles for convenience and pleasure that can do so without financial risk. The outlay in purchasing vehicles which represent both the horse and the wagon is necessarily great, and unless the trader is able to assure himself that he can have his work done more economically, more conveniently, and more rapidly, without increasing the percentage of cost of carriage, he naturally hesitates to make a change. There is a reasonable inclination, before making the plunge, to wait and see how the adventurous who first make the change come out of the venture.

But while such considerations have been "canny" and prudent, it is becoming more manifest month by month that conviction has come to the commercial community that the adoption of power haulage is a prudent and wise step, consistent with economy, advantageous in time-saving, making extension of deliveries more easy, and in more ways than one bringing about an increase of business. No one who observes can fail to see that the number of power vehicles carrying goods has been rapidly increasing, and continues to increase day by day. Observations taken in London show that from one-third to one-half of the commercial vehicles upon the street, in the busy thoroughfares round Trafalger Square, are now driven by mechanical power. Tests on recent occasions brought out:

COMMERCIAL VEHICLES.

Horse.	Motor.
92	54
66	33
120	71
91	57
30	24
17	18
30	22
446	279

But perhaps it may be said that London is not a fair criterion for the country generally. Here is a test taken when driving to Woking:

Horse.	Motor.
89	48

It must be understood that the figures, both of fast vehicles and commercial vehicles, vary up and down, and the statistics given may be held to be the most favorable to the power vehicle. But an average of tests brings out that, in the case

of the fast vehicles, the percentage of animal-drawn traffic is certainly not more than two or at most three, and in the case of the commercial vehicles the power-driven are certainly not less than a third, and often are nearer one-half. Thus fast horse vehicles are now a negligible quantity, and the progress in the adoption of mechanical power in the case of the commercial vehicle makes it plain that it too will in a very short time be the dominant factor in the traffic. In the case of trade vehicles, the removal of horses for war service will cause many people to turn to power-traction; therefore it is the power vehicle that has to be considered, and must be considered, when the question is: How are the roads to be made fit for their purpose in such circumstances?

Great Advance in Road Construction and Maintenance Methods

It is satisfactory to know that it is in this country that the greatest advance has been made in the ascertainment of the best mode of road construction and road maintenance. It is possible now in many places to drive for many miles in the driest weather without there being any raising of dust. This in itself is a thing of great advantage in the direction of comfort to the road user and roadside dweller, of prevention of deterioration of goods, and of maintenance of public health. But these, however satisfactory, may be called side advantages only. If a road is dustless it is not only satisfactory in these respects, but its condition testifies in an unanswerable manner to the fact that it is not a road that materially deteriorates under traffic. Its dustlessness is a proof that the surface is not crumbling away, but remains practically intact and therefore impenetrable to water. Water is the most deadly enemy that the road has to encounter if once it can penetrate below the surface. While the roads which are exhibiting this efficiency were at the time of construction to a certain extent experimental, the period during which they have stood the test of traffic—already equal to from two to four years in many cases—has enabled the road engineer to gain further experience and by experiment to work out improvement, so that it can now be said with confidence that the formula for a durable, dustless and economical road surface has been attained.

Disintegration of Old Roads

In former days the destruction of roads was caused by the penetration of water into the road crust in wet weather, and, in the case of very dry weather following, by the failure of the stones used in making it to hold their positions without moving, and so loosening the body of the roadcrust, and producing fatal disintegration. It was supposed by most people that the wear of the road was at the immediate surface only, whereas the actual injury caused by traffic not only affected the surface, but destroyed the entire roadcrust by causing movement of the stones in it far down below the surface. Examination showed that blows of the hoofs of the heavy cart horse and of wheels wherever the surface was uneven, resulting in motion far down in the crust, caused the sharply broken stones which had been laid down to move, and by chafing one against another to become loose in their seats more and more, until they resembled potatoes, from their angles being rubbed off. The road thus ceased to have any cohesion, so that the surface could not remain even, every horse or vehicle squeezing mud up in wet weather, and picking or pressing the stones out of their seats in dry weather. And this disintegration, being irregular in its effect at the surface, caused depressions in which water could lie Every one knows what is the state of an ordinary road shaded by trees for many days after a fall of rain.

Making Roads Impervious to Water

All this is, as regards the making or renewing of road surfaces or the construction of new roads, a thing of the past. Investigation and experiment have made it certain that a road can be constructed at a reasonable cost which will be impervious to water, will keep its surface unbroken for a long time, and which at any point where it shows signs of giving way can be made perfect by patching, without the Scriptural result of the new making the rent worse, as the quality of the patch and its surroundings will be practically the same. The lower crust of the modern road can be made so compact by the use of a well-proportioned binding material of ascertained quality that the mass is held firm, and cannot disintegrate by its pieces being moved and made to chafe one another so as to remove the sharply angled surfaces and reduce the crust to a non-cohering layer of rounded pieces. Also, it can be so made that water will not penetrate as it does into a road the only binding material of which is dirt. A stretch of such road, after being under traffic for two years or more, will be found with every stone still in the exact position in which it was fixed at first laying; and so tenaciously are the stones held by the well-chosen binding material that if a block cut out of the road is broken in two, it will be found that the stones are so firmly fixed that where the split stone comes opposite them they break across, leaving one-half fixed in each of the two pieces of the specimen of crust. No stronger testimony could be given to the excellence of the crust than this real evidence of the firm grip of the binder.

Carpeting the Roadcrust

But another improvement has been developed. Just as a carpet placed on a floor prevents vibration and deadens sound, so in the case of important roads in city or country combinations of bitumen with other materials are now used to put, as it were, a resilient carpet on the top of the resisting roadcrust, with the effect not only of lightening the blows of the traffic and so protecting the material below, but also of diminishing noise, saving wear and tear of vehicles, their frames, their tires, and their springs, and giving a greater mileage per gallon of petrol than can be the case if the road at the surface is rigid and in measure uneven, as it must be when the crust is exposed to the direct stroke of traffic of all classes of vehicles. Such a superimposed surfacing acts exactly as does a carpet in a room. It is slightly depressed where pressure comes on it; but when left alone, or when pressure comes on the carpet close to the depression, the depressed part rises again into position. A good turf is just an outdoor carpet. The foot of man or horse depresses it, and thus it is relieved from hard going; the turf rises again, either by being pressed down at a point close to the former depression or by being left untouched, and by its elasticity rising once more to the level. The bituminous surface which can now be put upon a road acts as the elastic turf does on a lawn; it yields, although of course in a slighter degree than the turf, and recovers, and so violence tending to destroy the weight-bearing crust is warded off. More durability is thus given to the body of the road, and an impervious surface is maintained. There is good reason to hope that roads covered with such a surface, proportioned in its thickness to the character of the traffic on the particular road, will last and remain in good order for a much longer period than has ever been the case hitherto, provided only that it is sufficiently inspected, and any incipient injury is dealt with at once. The repair of the road surface is easy, and if properly done gives as good and smooth a surface as ever.

Paying for Roads

With such good prospect before the community, there is one other matter which calls for legislative intervention. The burden of road construction and maintenance falls in the most uneven and unfair manner upon many localities There must be good roads provided between the great centers of population, and as matters at present stand the burden of doing this is in many cases most unjust to many districts. Such a road as that between Glasgow and Carlisle, or that between Carlisle and Preston, ought to be made and maintained in the best manner. But to put such a burden for many miles upon

low-rented pastoral subjects such as are found for miles on either side of Beattock Summit or Shap is most inequitable. Main roads such as these, and all other roads which can be classed as main roads, should be matters of imperial concern, so that the burden of construction and maintenance shall not fall oppressively upon poor localities. It is satisfactory to know that a move in this direction is being made. The road board is engaged in obtaining statistics of traffic, with a view to classifying roads and formulating a better system by which the burden may be more equitably distributed than at present. When a proper classification is provided, so that the roads which ought to be of first-class construction are scheduled, there is no reason to doubt that the engineer will be able to give a specification for road construction which will make it certain that the main road of the future will be a dustless, mudless, smooth and durable way, and that the cost spread over a period of years will not be greater than, if so great as, has now to be encountered to keep up a road passably good, but inefficient to a considerable degree in the qualities of a truly sound and efficient road. This must be made a matter of state duty, so that the burden may not fall unfairly, and that the work may be done with equal efficiency throughout. It is "a consummation devoutly to be wished."

Meanwhile the assurance can be confidently given that the production of the dustless, smooth, and efficient road has passed from the experimental to the practical stage. It is for the legislature to give the impetus to its realization in fact.

Cleveland Considers Broad Reorganization of Its Railroad and Interurban Transportation Facilities

The submission of a new railroad freight and passenger terminal plan to the people of Cleveland to accommodate all roads, including interurban electrics whose traffic would thereby be removed from the public streets to private rights-of-way has brought the city face to face with the question of abandoning the long expected Union Depot along the lake front at the foot of the Mall or Civic Center. The site of the new passenger station as proposed is next to and facing on the Public Square, while the old site contemplated a monumental passenger terminal building on the sightly bluff above the lake, this building completing the architectural plan of the Mall as originally designed by Messrs. Burnham, Carrere and Brunner, and later partially carried out by the Cleveland Group Plan Commission by the erection of several monumental city and county buildings and the preservation of site for others conforming to the original Mall Plan. The new plan contemplates not only union passenger facilities, but also freight houses at the high level of the business district and the co-ordination of railroad entrances under one terminal organization. Cleveland already has voted in favor of the old site. It is now contemplated to place before the voters an initiated ordinance covering the new plan.

Conflicting Requirements

The questions involved are so conflicting that numerous civic organizations are studying the two plans and to this end the Chamber of Commerce recently retained Mr. Bion J. Arnold of Chicago to report upon the important features of the controversy, covering an analysis of the comparative advantages and disadvantages of the two plans, the probable result in traffic congestion on the Public Square resulting from the concentration of seven or more stations into one union station and the practicability of largely organizing the passenger and freight carrying roads and terminal facilities in Cleveland. The most important question propounded to Mr. Arnold for solution is as follows:

> "Is it practicable to adjust freight and passenger terminals in this city to the future requirements of a city growing at the rate at which Cleveland is growing and still keep the union passenger station on the Mall site?"

Rapid Growth of Passenger Traffic

As both the street car and steam passenger traffic is growing so fast as to double in about eight years or less (and in the case of some roads in four or five years), the problem of meeting Cleveland's rapid growth is an important one. The Cleveland District is now estimated to hold nearly 1,000,000 persons and the great industrial expansion is already developing grave problems in housing. New freight facilities are already fully absorbed, their capacity is to be more than doubled, and it is contemplated in the new plan to direct all passenger traffic through Cleveland from the lake front tracks to a new interior right-of-way which is intended to be used also by the various interurbans entering Cleveland. These electric roads handle fully one-half as much passenger business as the steam roads.

Rapid Transit and Subway Development

The city is also studying rapid transit and subway development, new viaducts across the valley of the Cuyahoga and the straightening of this crooked stream to facilitate much needed harbor development.

The field survey and development studies of the Arnold investigation are already in progress, in charge of Mr. J. R. Bibbins of Chicago and a preliminary report will be shortly made public at a conference in Cleveland at which city and railroad officials and others prominently identified with this railroad question will be present.

The survey conducted by Mr. Bibbins follows identical lines of similar investigation made in connection with reports of Mr. Arnold on terminal development problems in Chicago, Baltimore, Syracuse, New Orleans and Jersey City, previously published. In these studies, the fullest co-operation and unification of railroad facilities have been urged, not only for passenger but also for freight. It remains to be seen whether such a policy as recommended by Mr. Arnold can now be adapted to the special conditions brought about by Cleveland's topography and extraordinary growth.

Good Roads a National Necessity After the War

By G. A. Kissel, President Kissel Motor Car Co., Hartford, Wis.

Without a doubt, every city or town has had brought home to it the value of good roads, and improved highways. Since the United States entered the war, the railroads have been gradually devoting more and more of their equipment to government requirements, thus leaving millions of tons of goods and supplies for home consumption to be transported and delivered as best it can. Thus cities whose highway commissioners had the foresight to put through good roads measures and see that they were carried through, had little or no difficulty in coping with these unexpected transportation problems. In such localities the motor truck took up the transportation problem with no loss of time and with a delivery and haulage expense that was not any greater, and in many cases less, than the rates paid the railroads.

Cities Surrounded by Poor Roads Are Isolated

But it is those cities and towns that have let the good roads problems go by, who have paid no attention to them, that are facing acute haulage problems. These are the municipalities whose merchants have great difficulties in keeping their shelves full; of being able to supply the ordinary wants and necessities of their trade. These are the municipalities which all of a sudden were shut off from the source of supply and as a result, have to pay higher prices for goods on account of the increased cost of transporting them to the points of distribution.

The United States has been in the war for over a year

and it would seem that every municipality would have by this time realized the necessity of building good roads to meet the future transportation demands of their respective localities. It was thought at one time that the railroads, after getting from under the first onslaught of government requirements, would be able to resume handling of local freight shipments destined for home consumption, but time has proven that such is not the case. With every increase in railroad equipment which factories have been able to build, a corresponding increase in goods to be shipped has been found to be the case in every part of the country.

Hence the bad roads municipality has had to struggle along, its merchants and business men paying increased expenses, which in the end is generally borne by the consumer and taxpayer.

Illinois Sets Good Example

With the possibility of this uncertainty on the part of the railroads extending well into the future, it is my opinion that every state should follow the example of Illinois in making plans for good roads to be constructed when the war is won. Illinois intends to build $60,000,000 worth of good roads. It is estimated that the principal and interest of this $60,000,000 bond issue will be paid in 25 years, by the constantly accumulating automobile license fees in the state treasurer's hands. Already there is more than $2,500,000 available.

Such a plan insures the kind of highways and byways that permit economical transportation of goods by motor trucks after the war, and at a time when the reconstructive efforts of the Untied States will be concentrated on devastated Europe.

Experience of Various Counties in Utilizing Local Deposits of Gravel on County Construction Projects

Rising prices of gravel and difficulties of getting shipments from the commercial producers during the past two seasons have compelled county engineers and road commissioners to give more attention to the possibilities of obtaining their own materials from local deposits. Coincidentally there has come a more extensive use of labor-saving machinery in working these local pits.

For the benefit of other county engineers, commissioners and highway contractors, Municipal and County Engineering has sought information from a number of counties using various types of machinery for excavating, screening and loading gravel and the observations of some of these operators of county gravel pits are presented herewith.

Possibilities of County Owned and Operated Gravel Pits Demonstrated in Racine County, Wis.

Development of nearby resources of natural road-building material has proved a very profitable venture for Racine County, Wis., as carried out by the county road commission under the direction of Otto A. Klein, chairman, and F. E. Oversen, superintendent. The county plant made about $2,000 above operating expenses this year, according to Supt. Overson, and furnished all the gravel required for the county's own work at a low cost. The scene of operations is a huge hill of gravel near Burlington, Wis. A complete, well-designed screening plant with bins is built against the side of the hill, buttressed with concrete retaining walls. A railroad siding runs alongside the plant and the gravel is handled by rail from the bins to unloading points as close as possible to the scene of the construction work for which the material is intended. Supt. Overson gives us the following information about his plant:

"We have loaded as high as 15 cars a day and have averaged 10 cars a day for several weeks at a stretch; but that was in 1917. I have run the plant with three men this year and at that we have loaded 10 and 11 cars some days. Often we could not get any cars at all. If we could have all the cars we could use, we could turn out 1,400 cars a season without much exertion. As to the profit, we have made about $2,000 above operating expenses so far this season on an output of about 18,000 yds., and have supplied all the gravel needed for the various county building operations at about 25 cts. per cu. yd. cheaper than it could be purchased in the market. With a yearly output of 50,000 yds., which is possible, this plant will be a fine investment for Racine county. We charge 40 cts. per cu. yd. for the gravel loaded into the cars. Thus, an average day's run of 10 cars or 330 yds. would bring $130. The operating expenses are less than $40 a day, including wear and

VIEWS AT RACINE COUNTY GRAVEL PIT.
Showing the Sauerman Power Scraper in the pit; the bars where the scraper dumps; and the complete plant.

tear on machinery. This gives an idea of the possibilities of a county owned and operated pit.

"Our excavating machine is a Sauerman Power Scraper of 1 cu. yd. capacity, operated by a 50 H. P. double drum Thomas steam hoist. This whole outfit cannot be improved upon for our work."

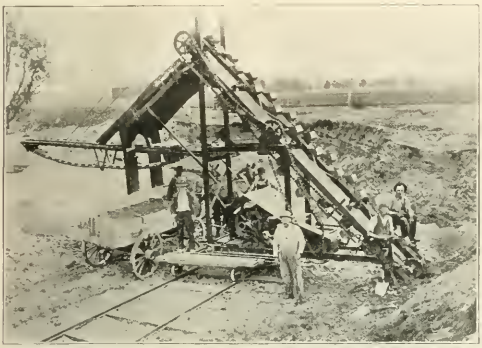
Township Plant in Michigan

James Kavanaugh, commissioner of North Shade Township, Ionia County, Michigan, writes as follows of his experience in excavating and screening materials for township road work:

"We have got out our material with a very few men in the pit this season by using an 'Ever Clean' gravel screen made by the Beach Mfg. Co., Charlotte, Mich. The illustration herewith shows a typical scene in our pit. We have had 35 teams

and dump wagons hauling away sand and gravel most of the time and the screening plant has turned out the material fast enough so the teams were always on the move.

"The screening plant is mounted on wheels and can be moved to a new location and made ready to operate in 30 minutes. This makes it easy to keep close to the bank so there is a short haul for scraping the material into the boot of the elevator. The screen successfully handles wet material and we have operated it in all kinds of weather."



IN A CALHOUN COUNTY (MICH.) GRAVEL PIT
This Michigan Jr. Gravel Excavator and Screener is a Great Labor-saver.

Experience in Oakland County, Mich.

The difficulties of carrying on road construction in Oakland County, Michigan, with a depleted force of men were mitigated when gravel screening and loading plants were installed according to Leon V. Belknap, County Engineer. He writes as follows:

TWO MEN SCREEN 100 YDS. A DAY.
One man in pit and one at hoisting engine of cableway operate this Oakland County (Mich.) plant.

"The Oakland County Road Commission have installed a few gravel screening and loading plants in various parts of the county. These plants have proven to be an economy in the delivering of gravel of the required specifications by eliminating considerable labor and expense in operation.

"The outfit shown herewith consists primarily of a Galion "Imperial" screening plant supplemented by a 10 H. P. gasoline engine, equipped with double drum hoisting outfit and necessary cable, etc., to operate two scrapers. One end of this cable is fastened to a drum of the hoisting machine and then passes through two pulleys attached to a post or mast, thence through blocks fastened to dead men at two separated points and thence back again through blocks on the post to the second drum of the hoist. Two scrapers are fastened to these sections of cable between post and dead men so that one unloads at the plant while the other is loading in the pit. The travel of the cable is approximately 150 ft. a minute.

SCREENING PLANT OWNED BY TOWNSHIP.
This "Ever Clean" Gravel Screener keeps 35 teams busy hauling away gravel.

"The material is dropped on bars spaced 2 ins. apart, which separates large stone from gravel. The stone slides into a hopper and is then removed by wagons. The gravel drops through bars into the buckets of the screening plant, and is passed through the screens and separated as required.

"Gravel for road purposes was screened through this plant and the large stones and a portion of the sand were removed. The average amount of gravel per day of screened material realized from this plant was 90 cu. yds. The cost of operating screening plant was 43 cts per yd.; this price including loading of motor trucks. Two men operated the plant; one in the pit and the other at the hoisting engine."

ONE OF LOGAN COUNTY (ILL.) GRAVEL PLANTS.
Excavating Pit-run Material with Sauerman Dragline Cableway Excavator.

Experience in Calhoun County, Mich.

The county road commissioners of Calhoun County, Michigan, have found machinery a profitable investment in developing local gravel deposits. They have purchased four Michigan Jr. Gravel Screeners during the last two seasons. This screener, manufactured by the Jordan & Steele Mfg. Co., Charlotte, Mich., is a unique machine, for it is an excavator, screener and loader combined. It runs up and down the side of the pit on a track and takes off a slice about 4 ft. each time over the track. Concerning their success with this machine, A. A. McKay, engineer of the Calhoun County road commission, writes us as follows:

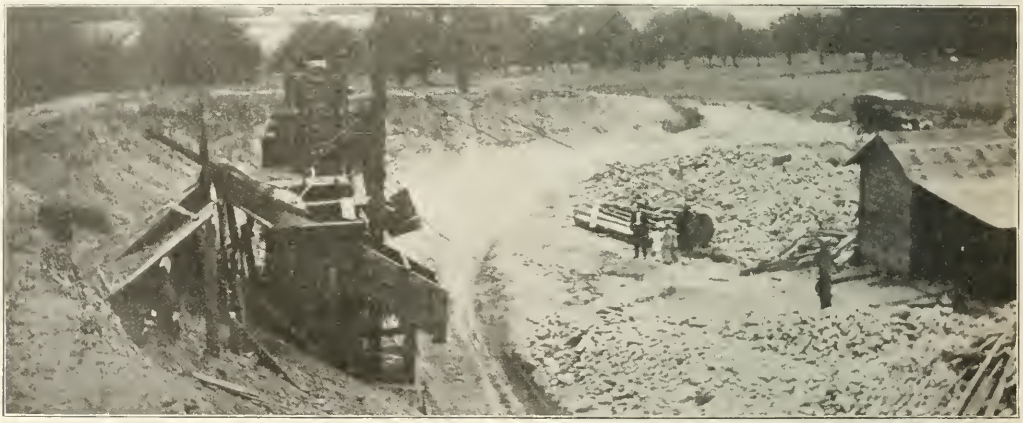
"As an example of what can be accomplished with a Michigan, Jr. Gravel Screener, I might give you the results secured from one year's work of one of the four that this county owns. The machine was purchased and delivered in May, 1917, and used continuously until the middle of October in one pit. While there a total of 6,500 cu. yds. of screened gravel was placed on approximately 5 miles of highway, the longest haul being 3½ miles. The sand and oversize stone left in the pit equalled more than twice the amount of gravel taken out. The natural material in the pit was unsuitable for road purposes without screening and by using the screener we obtained enough better material above the standard specification of 60 percent. to secure the county a total of $550 extra state aid or reward.

"Had we attempted to screen the pit run material by hand we would have been able to build but one-half the amount of road during the summer, and it would have cost double. The average cost of placing this material on wagons covering the season's work which includes all lost time on account of bad weather, delays, etc., was about 28 cts. per cu. yd., with nothing allowed for depreciation. On this summer's work (1918) on similar jobs, our cost per cubic yard runs from 16 to 40 cts., the higher cost resulting from having a snap team in the pit at a cost of $6 per day and an extra large amount of sand to contend with.

"On the job first above mentioned had we not secured the screener we would have had to ship in the gravel at a cost of $1.20 per yard f. o. b. cars two miles from the road. On a similar pit worked the year previously, where we erected a large trap and carried the pit run material to it with teams and wheelers with three wagons passing under to take sand, stone and gravel, the average cost per yard of gravel in wagons was 98 cts.

"After the machine had finished the job first above mentioned it was moved to another pit several miles away and about 1,600 yds. run through. Then it was moved to another job about 15 miles away, and by May 15, 1918, an additional 2,900 cu. yds. had been run through. All this was in pits where the amount left would more than equal the amount taken and gave us material that always ran better than the specifications required, which in turn gave us better roads and more state aid.

"The story of one machine is duplicated by each of the others. In pits where there is enough pebble the machine will take out the oversize stone, also load quickly and with few men which is a big advantage when men are scarce. In this state gravel pits run to pockets of sand and pebble; it is very seldom that we can secure bank run gravel for any length of time without having the pit show up sand pockets."



ONE OF THE GRAVEL PLANTS WHICH PLAY LARGE PART IN OAKLAND COUNTY (MICH.) ROAD-BUILDING.
This is a Galion "Imperial" screening outfit, supplemented with a hoist and cableway for operating two scrapers which dig and carry the material from the pit to the elevator boot of the screening plant.

Experience in Logan County, Illinois

The road commissioners of Logan County, Illinois, made their first venture in the direction of furnishing their own material for building and maintaining county roads in the spring of 1917. Several fine gravel deposits were available for their use, but in all cases water was very close to the surface, preventing the usual dry methods of pit working, and making the use of a dragline cableway excavator advisable.

It was decided to open one pit first to produce pit-run material which was needed in large quantities, chiefly for township maintenance work. A Sauerman dragline cableway outfit with 1-yd. excavator bucket was installed, to be operated by a 9x10 Thomas steam hoist. A 35 H. P. vertical boiler furnished the power. This plant was very successful, so much so that the county opened a second pit before the end of the season, duplicating the first plant in its entirety and providing for the addition later of screens and bins for producing washed material.

The first plant produced about 35,000 cu. yds. of unscreened material in 175 working days before the first pit was exhausted, according to the report of J. C. Wigginton, who was then county superintendent of highways. The plant was then dismantled and moved to a new pit at a cost of about $400 for dismantling and re-erecting.